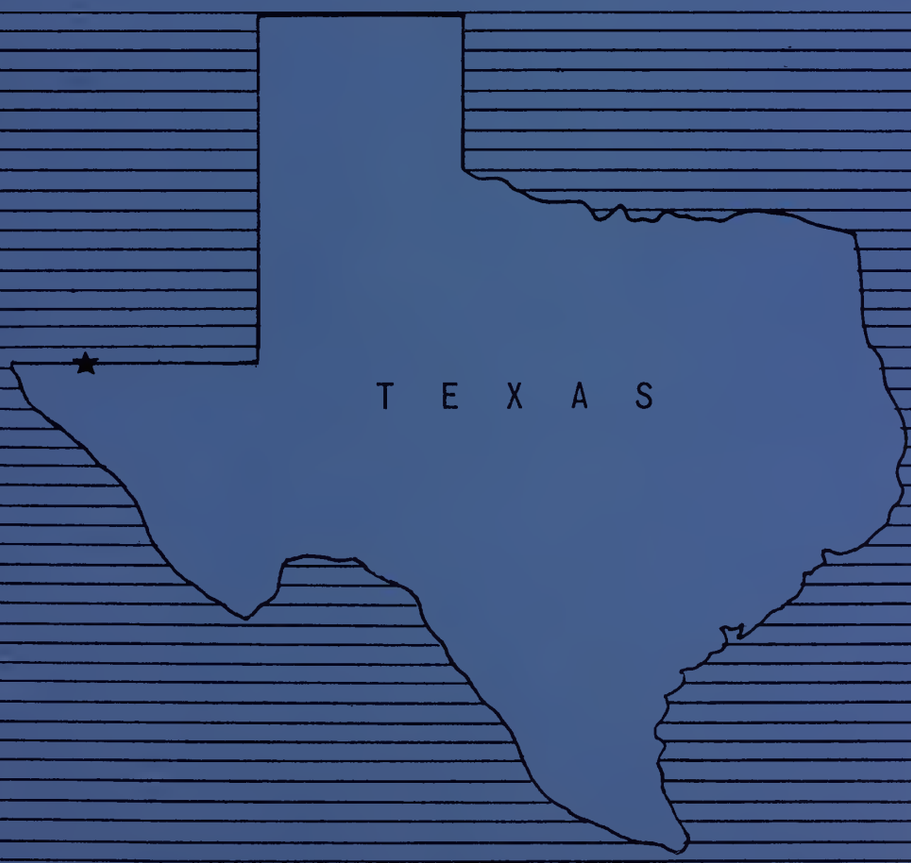
WATERSHED WORK PLAN

FOR WATERSHED PROTECTION AND FLOOD PREVENTION

CORNUDAS, NORTH AND CULP DRAWS WATERSHED

HUDSPETH COUNTY, TEXAS and OTERO COUNTY, NEW MEXICO



October 1969

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WATERSHED WORK PLAN AGREEMENT

between the

Otero Soil and Water Conservation District, New Mexico
Local Organization

El Paso-Hudspeth Soil and Water Conservation District, Texas
Local Organization

Otero County Commission, New Mexico
Local Organization

Hudspeth County Commissioners Court, Texas
Local Organization

Hudspeth County Underground Water Conservation District No. 1, Texas
Local Organization

City of Dell City, Texas
Local Organization

States of New Mexico and Texas
(hereinafter referred to as the Sponsoring Local Organization)

and the

Soil Conservation Service
United States Department of Agriculture
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organization for assistance in preparing a plan for works of improvement for the Cornudas, North and Culp Draws Watershed, States of Texas and New Mexico under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organization and the Service a mutually satisfactory plan for works of improvement for the Cornudas, North and Culp Draws, States of Texas and New Mexico, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organization and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about 10 years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:

1. The Sponsoring Local Organization will acquire without cost to the Federal Government such land rights as will be needed in connection with the works of improvement. (Estimated cost $37,960.)

2. The Sponsoring Local Organization will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to State law as may be needed in the installation and operation of the works of improvement.

3. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organization and by the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Construction Cost (dollars)
3 Floodwater Retarding Structures	-	100	1,351,440

4. The percentages of the engineering costs to be borne by the Sponsoring Local Organization and the Service are as follows:

Works of Improvement	Sponsoring Local Organization (percent)	Service (percent)	Estimated Engineering Costs (dollars)
3 Floodwater Retarding Structures	-	100	72,065

5. The Sponsoring Local Organization and the Service will each bear the costs of Project Administration which it incurs, estimated to be $1,500 and $198,770 respectively.

6. The Sponsoring Local Organization will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.

7. The Sponsoring Local Organization will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.

8. The Sponsoring Local Organization will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.

9. The Sponsoring Local Organization will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.

10. The costs shown in the agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.

11. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

    A separate agreement will be entered into between the Service and the Sponsoring Local Organization before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

12. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.

13. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.

14. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the regulations of the Secretary of Agriculture (7 C.F.R. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving Federal financial assistance.

Otero Soil and Water Conservation District, New Mexico
Local Organization

By Frank Bremfield

Title Member

Address Dell City, Tex. 79837
Zip Code

Date Jan. 21, 1971

The signing of this agreement was authorized by a resolution of the governing body of the Otero Soil and Water Conservation District, New Mexico adopted
Local Organization

at a meeting held on Jan. 4, 1971

W. F. Gage
(Secretary, Local Organization)
W. F. Gage

Address Pinon, N.M. 88344
Zip Code

Date Jan 4, 1971

El Paso-Hudspeth Soil and Water Conservation District, Texas
Local Organization

By Ray McCoy
Ray McCoy

Title Vice Chairman
Vice Chairman

Address Dell City Tx. 79837
Zip Code

Date 1/21/71

The signing of this agreement was authorized by a resolution of the governing body of the El Paso-Hudspeth Soil and Water Conservation District, Texas
Local Organization
adopted at a meeting held on 1-12-71

R. E. Bills
(Secretary, Local Organization)
R. E. Bills

Address 6326 Gateway East El Paso 79905
Zip Code

Date 1-12-71

Otero County Commission, New Mexico
Local Organization

By Dan Virden
Dan Virden

Title Otero County Commr
County Commissioner

Address Box 1749 88310
Zip Code

Date 21 Jan 71

The signing of this agreement was authorized by a resolution of the governing body of the Otero County Commission, New Mexico adopted at a meeting held
Local Organization
on Jan 4 1971

Clifton G. McDonald
Clifton G. McDonald
(~~Secretary, Local Organization~~)
CHAIRMAN OF THE BOARD

Address 915-10th St
Zip Code

Date Jan 4 1971

Hudspeth County Commissioners Court, Texas
Local Organization

By C D Lee

J. D. Lee
Title Commissioner
County Commissioner

Address Box 171 - 79837
Zip Code

Date 1-21-71

The signing of this agreement was authorized by a resolution of the governing body of the Hudspeth County Commissioners Court, Texas adopted at a meeting held on 1-11-71
Local Organization

Bernice M. Elder
(Secretary, Local Organization)
County Clerk Bernice M. Elder

Address Sierra Blanca, Texas
Zip Code 79851

Date January 11, 1971

Hudspeth County Underground Water Conservation District No. 1, Texas
Local Organization

By George S McConnell
George S. McConnell

Title Pres President

Address P O Box 96 Dell City Texas
Zip Code

Date 1-21-71 79837

The signing of this agreement was authroized by a resolution of the governing body of the Hudspeth County Underground Water Conservation District No. 1, Texas
Local Organization
adopted at a meeting held on December 17, 1970

James Lynch
(Secretary, Local Organization)
James Lynch

Address P.O. Box 182

Dell City, Texas 79837
Zip Code

Date 12/17/70

City of Dell City, Texas
Local Organization

By I. E. Franklin
I. E. Franklin

Title Mayor Pro Tem
Mayor Pro Tem

Address Dell City, Texas 79837
Zip Code

Date Jan. 21-1971

The signing of this agreement was authorized by a resolution of the governing body of the City of Dell City
Local Organization

adopted at a meeting held on January 12, 1971

Lawayne Kasparian
Lawayne Kasparian
(Secretary, Local Organization)

City of Dell City

Address Box 175, Dell City 79837
Zip Code

Date January 13, 1971

Soil Conservation Service
United States Department of Agriculture

By _____

Date _____

WORK PLAN

FOR

WATERSHED PROTECTION AND FLOOD PREVENTION

CORNUDAS, NORTH AND CULP DRAWS WATERSHED
Hudspeth County, Texas, and Otero County, New Mexico

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act, (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Prepared By:

Otero Soil and Water Conservation District

El Paso-Hudspeth Soil and Water Conservation District

Otero County Commission, New Mexico

Hudspeth County Commissioners Court, Texas

Hudspeth County Underground Water Conservation District No. 1

City of Dell City, Texas

With Assistance By:

U. S. Department of Agriculture
Soil Conservation Service
October 1969

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WATERSHED WORK PLAN

CORNUDAS, NORTH AND CULP DRAWS WATERSHED
Otero County, New Mexico, and Hudspeth County, Texas
October 1969

SUMMARY OF PLAN

General Summary

The work plan for watershed protection and flood prevention for the Cornudas, North and Culp Draws watershed was prepared by the Otero and the El Paso-Hudspeth Soil and Water Conservation Districts, the Otero County Commission, New Mexico, the Commissioners Court of Hudspeth County, Texas, Hudspeth County Underground Water Conservation District No. 1, and the city of Dell City, Texas. Technical assistance was provided by the Soil Conservation Service of the U. S. Department of Agriculture. The Bureau of Sport Fisheries and Wildlife of the U. S. Department of the Interior collaborated with the Texas Parks and Wildlife Department and the New Mexico Department of Game and Fish in the preparation of a reconnaissance report on the fish and wildlife aspects of the watershed. Office space was furnished the work plan staff by the sponsoring local organizations.

Cornudas, North and Culp Draws watershed, comprising an area of 277.5 square miles (177,600 acres), is located in the southeastern portion of Otero County, New Mexico, and the northeastern portion of Hudspeth County, Texas. About 140,250 acres, of which 37,500 acres is state owned, is located in New Mexico and 37,350 acres is located in Texas. The Bureau of Land Management administers about 50,000 acres of federal land within the New Mexico portion of the watershed. The watershed is located about 75 miles southeast of Alamogordo, New Mexico, and about 45 miles southwest of Carlsbad Caverns National Park. Approximately 9 percent of the watershed is irrigated cropland, 90 percent is rangeland, and 1 percent is in miscellaneous uses such as roads and farmsteads.

The principal problems in the watershed are frequent damages from floodwater, sediment, and scour which occur on 14,173 acres of highly productive flood plain.

The estimated average annual floodwater, sediment, erosion, and indirect damages, without a project, total $266,707 at adjusted normalized prices. Project objectives are the proper use, treatment, and management of the watershed's soil and water resources, the protection of the flood plain lands, and the stimulation of the economic development of the area. The project, as formulated, meets these objectives.

The work plan proposes the installation, during a 10-year period, of a project for the protection and development of the watershed at a total cost of $3,215,070. The share of these costs to be borne by Public Law 566 funds is $1,671,740. The share to be borne by other than Public Law 566 funds is $1,543,330. In addition, the local interests will bear the entire cost of operation and maintenance.

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Land Treatment Measures

Landowners and operators will establish and maintain needed land treatment measures on 10,968 acres of cropland and 110,072 acres of grassland at an accelerated rate during the 10-year installation period in addition to the maintenance of those measures already applied. These measures will improve the hydrologic condition of both cropland and grassland and will improve the efficiency of irrigation systems. This improvement in soil condition and cover will reduce sediment to floodwater retarding structures and will effect some reduction in flooding. The improved efficiency of irrigation systems will conserve precious irrigation water. The installation cost of these land treatment measures is estimated to be $1,553,335, of which $1,503,870 will be from funds other than Public Law 566. Public Law 566 funds will provide $49,465 in order to accelerate technical assistance needed for the conservation planning, application, and maintenance of these measures.

Structural Measures

The structural measures included in the plan consist of 3 floodwater retarding structures. The estimated total cost of structural measures is $1,661,735, of which the local share is $39,460, and the Public Law 566 share is $1,622,275. The local share of the cost consists of land rights and project administration (table 1).

Benefits

The reduction in floodwater, sediment, and erosion damages will benefit directly the owners and operators of about 50 irrigated farms. Thirty-five of these are family-type farms employing less than 1½ man-years of outside labor. The installation of all measures, both land treatment and structural, will benefit about 62 farm and ranch operators. About 14,173 acres of flood plain will receive flood protection benefits. Damages after project installation will be reduced from an average of $266,707 annually to $38,616, or 86 percent. The average annual primary benefits accruing to structural measures to be built in this watershed are estimated to be $307,851. Of this amount, $121,448 is the result of damage reduction, $37,842 results from incidental ground water recharge, and $148,561 is the result of damage reduction in Hitson, C&L, and Washburn Draws watershed. Secondary benefits will amount to $28,330, of which $11,041 will accrue as the result of damage reduction in this watershed, $13,505 from the result of damage reduction in Hitson, C&L and Washburn Draws watershed, and $3,784 from incidental ground water recharge. The ratio of total annual benefits ($336,181) resulting from the installation of structural measures to the annual cost ($86,129) is 3.9 to 1.0.

Provisions for Financing Local Share of Installation Cost

Funds for the local share of the cost of installing the structural measures will be provided by the Otero County Commission and the Hudspeth County Commissioners Court from existing tax sources.

Operation and Maintenance

Land treatment measures for watershed protection will be operated and maintained by landowners or operators of the farms or ranches upon which the measures will be installed under agreements with the Otero and the El Paso-Hudspeth Soil and Water Conservation Districts. The land treatment measures installed on federal land by the Bureau of Land Management will be maintained by that agency. The responsibility of the Hudspeth County Commissioners Court will be the operation and maintenance of floodwater retarding structure No. 1 and maintenance of structure No. 2. The Otero County Commission will have the responsibility for operation of structure No. 2 and operation and maintenance of structure No. 3.

The estimated average annual cost of operation and maintenance is $400.

DESCRIPTION OF THE WATERSHED

Physical Data

Cornudas, North and Culp Draws watershed is a portion of a larger watershed which also includes Hitson, C&L and Washburn Draws (figure 1). Cornudas, North and Culp Draws originate in Otero County, New Mexico, and Hitson, C&L and Washburn Draws originate in Hudspeth County, Texas

The watershed is located about 75 miles southeast of Alamogordo, New Mexico, and about 45 miles southwest of Carlsbad Caverns National Park, which attracts tourists from over the entire nation. The aforementioned draws, with the exception of Culp Draw, contribute floodwaters to a broad alluvial plain known as Dell Valley. The flood plain, which is intensively cultivated and irrigated, lies on the west side of the Dry Salt Lakes in the semi-desert enclosed Salt Basin of western Texas and southern New Mexico.

This interrelated drainage area has been divided into two watersheds to facilitate the planning and application of works of improvement. The local sponsoring organizations have requested that these two watersheds be planned concurrently since they are component parts of the larger watershed.

This work plan for watershed protection and flood prevention concerns the Cornudas, North and Culp Draws portion of this interrelated watershed.

The intermittent draws of Cornudas and North originate in the Cornudas Mountains in New Mexico about 24 miles northwest of Dell City. Cornudas Draw flows into Texas about 7 miles northwest of Dell City and North Draw about 4 miles north. Flows from Cornudas Draw combine with flows from Washburn Draw into an overland-type flow on a common flood plain west of Dell City. These overland flows in turn combine with the flows from North Draw on the common flood plain northeast of Dell City. There are no defined channels in the Dell Valley flood plain to carry the overland flows to the Dry Salt Lakes. The floodwaters are blocked, temporarily impounded and diverted by physical improvements such as irrigation ditches and canals, roads, and diversions. Culp Draw, a small tributary which drains an area on the eastern side of the watershed, flows across flood plain lying mainly in New Mexico.

The flow enters the Dry Salt Lakes in Texas near the Texas and New Mexico state line. Runoff reaching the lakes is impounded until evaporated.

The total drainage area included in this project is 277.5 square miles, or 177,600 acres, of which 219.14 square miles or 140,250 acres are in Otero County, New Mexico, and 58.36 square miles or 37,350 acres are in Hudspeth County, Texas. Dell City lies immediately south of the area included in this project.

The topography ranges from mountainous in the west to gently sloping on the Dell Valley flood plain. Prominent igneous peaks in the Cornudas Mountains rise 2,000 feet or more above the surrounding steeply rolling limestone uplands in the western part. A small cone-shaped igneous peak, Round Mountain, is located 3 miles east of Dell City and rises about 175 feet above the Dell Valley flood plain. The bed of the Dry Salt Lakes on the eastern side is about 40 feet lower than the low eastern edge of the flood plain. Elevations above mean sea level range from 7,280 feet on Wind Mountain Peak in the Cornudas Mountains to 3,614 feet in the Dry Salt Lakes.

The rocks exposed in the watershed consist of sedimentary and igneous rocks ranging from Permian to Recent age. Permian age limestone crops out over most of the uplands area. Tertiary age intrusive igneous rocks occur in the mountain areas. Outwash, alluvial, and lacustrine deposits cover areas of the watershed along the draws and Dell Valley. Salty lacustrine sediments, mainly sulfates, have been covered by Recent calcareous alluvial sediments in parts of the valley. The total thicknesses of these valley deposits range from a few feet to more than 150 feet over limestone bedrock. The salty lake sediments under the Dry Salt Lakes occur to depths of more than 1,500 feet. Aerial photographs reveal the existence of old shorelines of a Pleistocene lake which impounded water more than 40 feet above the present bottom of the Dry Salt Lakes.

The geologic structure of the limestone beds in the watershed has been greatly affected by regional block faulting and igneous intrusion. Faulting occurs along the eastern side under the alluvial flood plain and lake sediments and in the uplands near Culp Draw. Faulted and tilted beds also occur in the vicinity of the mountains.

The soils of the watershed are of the Southern Desertic Basins, Plains and Mountains Land Resource Area. Small areas of inaccessible mountain soils, important only for wildlife, occur in the western part. Most of the upland area is made up of soils of the Lozier Series. These soils support a grass vegetation at elevations above 4,500 feet and are used for grazing of livestock. At lower elevations, however, these soils produce only a low value, desert shrub type vegetation. Large areas of soils of the Simona and Mimbres Series occur on the alluvial plains below the mountains and along the draws. The deep soils of the Mimbres Series are watered by runoff from the surrounding steeper uplands and produce good yields of grass for livestock production. The less deep Simona soils are on undulating plains below the mountains and provide fair yields of grass.

The intensively irrigated alluvial plain surrounding Dell City is made up of soils of the Hoban, Pajario, and Monahans Series. Good permeability, absence

of restrictive horizons, and lack of high water table permit leaching of excess salts from these irrigated soils. Gypseous soils occur in an area along the Dry Salt Lakes on the eastern side of Dell Valley. These soils support salt-tolerant vegetation which is used for limited grazing.

All cropland and pasture in the watershed is irrigated with ground water obtained from a shallow aquifer under Dell Valley. The ground water occurs in a cavernous formation, the Victorio Peak Limestone, at depths of 40 feet in the eastern part to 150 feet or more west and northwest of Dell City. The area of the aquifer is extensive and productive capacity is high. Wells producing as much as 6,000 gallons per minute, with little apparent drawdown, are common throughout the valley. Some deep irrigation wells west of Dell City penetrate more than 800 feet of water-bearing cavernous limestone. Oil test wells in the limestone uplands farther west indicate that cavernous fresh water may occur to depths of several thousand feet. Water movement in the aquifer is rapid. The natural recharge area includes the limestone uplands lying west and northwest of the Dell Valley in Texas and New Mexico and the Sacramento River area in New Mexico. The water surface in the cavernous aquifer is nearly level, and before irrigation began was higher in elevation than the beds of the Dry Salt Lakes. Ground water from the aquifer was discharged through springs, such as the historic Crow Springs at the old Butterfield Stage Station on the east side of the lakes, and by evaporation of capillary water from the surface of the lake beds. It is estimated that more than 40,000 acre-feet of water can be discharged annually by evaporation of capillary water from the Dry Salt Lakes area (Page U67, Bulletin 6502, Texas Water Commission, 1965).

The quality of the ground water under Dell Valley has slowly deteriorated over the past 20 years because of pollution of salts leached from the irrigated soils. This problem is most severe in the central part of the irrigated area. Water quality before irrigation development in 1948 appears to have been fairly uniform throughout the valley and was slightly saline.

The over-all land use in the watershed is as follows:

Land Use	Acres	Percent
Cropland	16,713	9.4
Pasture	432	0.3
Rangeland	159,154	89.6
Miscellaneous[1/]	1,301	0.7
Total	177,600	100.0

1/ Includes roads, highways, farmsteads, and wildlife areas.

The average annual precipitation varies from 8 inches in the low-lying desert valley to 12 inches in the mountainous and upland area. Most of the floods result from high intensity, short duration storms during late summer and early fall. The mean annual temperature is 61° Fahrenheit. Temperatures ranges from 12° to 108° Fahrenheit. The average frost-free season is approximately 230 days in the highly intensified irrigated area, resulting in an

average growing season lasting from the latter part of March until the middle of November.

Mineral production in the Dell Valley area is minor. There is no oil or gas production. Gravel deposits are extensive and some gravel has been produced from a pit located about 4 miles northwest of Dell City. Materials for county road construction and maintenance are obtained from numerous small pits scattered throughout the valley. There is no mining of salt products from the Dry Salt Lakes lying east of Dell City.

Economic Data

The economy of the watershed depends entirely upon agriculture. The majority of the agricultural income is derived from crops such as grain sorghum, cotton, alfalfa, corn for grain and ensilage, small grain, truck crops, and a nursery. The balance of the agricultural income results from the cattle industry. The flood plain lands are used as follows: grain sorghum, 31 percent; cotton, 28 percent; alfalfa, 14 percent; corn, 10 percent; small grain, 8 percent; truck crops such as onions and tomatoes, 1 percent; pasture, 2 percent; and miscellaneous uses such as farmsteads, roads, etc., 6 percent. Normal flood-free yields expected from grain sorghum are 6,000 pounds per acre; Pima long staple cotton, 700 pounds; Kala upland long staple cotton, 1,000 pounds; alfalfa, 7.5 tons; corn for ensilage, 25 tons; barley, 80 bushels plus 1.5 animal unit months grazing; onions, 25 tons; tomatoes, 10 tons. Market value of land varies from $20 to $500 per acre, depending upon location and soil capability. The average gross return from crop production is between $56,000 and $57,000 per farm. Additional revenue results from the sale of livestock products. These farm and ranch units support businesses in Dell City which provide supplies and services required for farming and ranching operations.

There are about 62 operating farm and ranch units in the watershed. About 50 of these units are irrigated cropland farms averaging 334 acres in size. Twelve large ranches comprise the balance of the watershed. Thirty-five of the farms are family-type farms hiring less than 1½ man-years of outside labor. There is one small low-income farm whose owner works off the farm in order to maintain an adequate standard of living. All of these farms suffer damage from flooding.

The Bureau of Land Management administers 50,000 acres of federal land located in the project area. The State of New Mexico owns 37,500 acres of land and the remainder of land in the watershed is privately owned.

There are no towns in the watershed; however, nearby Dell City, population 500, provides schools, churches, services, and supplies needed by the residents. Students residing in New Mexico attend the elementary grades in Cinega school in New Mexico and then attend high school at Dell City. The nearest doctors and hospitals are in El Paso, the main trading center for this section of the state and adjoining areas in New Mexico. The community has purchased and operates an ambulance for emergency service to the hospitals.

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Good highways link the watershed with other population and marketing centers in all directions, except north into New Mexico. Approximately 5 miles of paved roads and 103 miles of unpaved roads serve the watershed residents.

Land Treatment Data

The Otero and the El Paso-Hudspeth Soil and Water Conservation Districts, with technical assistance from Soil Conservation Service personnel headquartered at Alamogordo, New Mexico, and Dell City, Texas, respectively, have aided owners and operators of watershed lands in the development of basic soil and water conservation plans and the application of needed land treatment measures.

There are 62 operating units located wholly or partially within the watershed. Soil and water conservation plans have been developed on 50 of these, representing about 64 percent of the agricultural land in the watershed.

Included in these operating units is approximately 50,000 acres of rangeland administered by the Bureau of Land Management. The bureau is responsible for the application of needed land treatment measures on this acreage. These units include also about 37,500 acres of land owned by the State of New Mexico. This land is leased and managed in the same manner as privately owned land.

The Agricultural Conservation Program, administered by the Agricultural Stabilization and Conservation Service, has also provided financial assistance for the application of land treatment measures.

It is estimated that needed land treatment has been applied to about 40 percent of the agricultural land in the watershed. Installation of some conservation measures for irrigated cropland and pastureland have lagged because of their expense. Table 1A lists those measures and amounts which have been applied. The total cost of this application is estimated at $1,113,481.

Fish and Wildlife Resource Data

The fish and wildlife habitat, species, and populations in the watershed are described by the Bureau of Sport Fisheries and Wildlife as follows:

> Natural vegetation on the uplands consists of mesquite, creosote bush, grama grasses, sand dropseed, and burrograss. The upland draws support growths of vine mesquite, plains bristlegrass, cane bluestem, bush muhly, and alkali sacaton. Very little natural vegetation grows in the lowlands.
>
> . . . . . .
>
> There is not enough permanent water in the project area to provide significant sport or commercial fishing.

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No game species is abundant in the watershed. The most common game animal is the scaled quail, with a few pronghorn antelope and mule deer in some areas. There is little hunting on private land because of the scarcity of game and disinterest on the part of the landowners to allow hunting. The Federal and state lands are open to free public access, but hunting on them is light. Without the project, future wildlife populations would be expected to remain at their present levels.

WATERSHED PROBLEMS

Floodwater Damage

The principal problem in the watershed is flood damage to 14,173 acres of flood plain. Of this amount, 2,100 acres are damaged by floodwaters from Culp Draw. This is the acreage which was inundated by the 1966 flood, the largest on record. The source of floodwaters in Culp Draw can be determined readily; however, floodwaters affecting the balance of the watershed cannot be separated as to source or origin. The following description of watershed problems concerns those of Cornudas, North and Culp Draws watershed regardless of origin of waters causing the problems.

Damaging floods can be expected on an average of at least once every two years. Floods causing minor damages occur when local runoff exceeds the capacity of road ditches and other man-made means of conveying the water. The problem is compounded in that there are no defined natural channels in the irrigated cropland area. Large floods are caused by precipitation falling in the upland and mountainous areas. The acreage inundated is dependent upon the areal extent, intensity, and amount of precipitation. It is estimated that a 1 percent chance flood will inundate about 9,400 acres. Most floods occur during the months of July and August when crops are highly susceptible to damage. Damage to other agricultural property is extremely severe. An acre of irrigated cropland represents a great monetary investment in concrete-lined ditches, concrete pipelines, appurtenances for water control, and land leveling.

Little authentic information pertaining to flooding is available prior to the drilling of irrigation wells and the development of this land for irrigation in 1948. Damaging floods are known to have occurred in 1949, 1952, 1954, 1955, 1957, 1958, 1960, 1962, 1963, 1964, 1965, 1966, and 1968.

Runoff from the storm of August 22 and 23, 1966, resulted in the largest flood in Dell Valley's recorded history. Recorded rainfall amounts for this storm varied from 2.58 inches at the Weather Bureau station at Cornudas Service Station, located about 20 miles southwest of the watershed, to unofficial reports of 12 inches at the center of the storm, located about 10 miles northwest of Dell City. A storm of this magnitude has less than 1 percent chance of occurring in any given year. Runoff from this storm devastated the irrigation systems and destroyed crops throughout the watershed. Concrete-lined ditches were broken as if by giant hammers, and large

sections weighing tons were washed away. Many miles of these ditches required replacement and thousands of acres of irrigated cropland required re-leveling in order that the business of farming could be continued. This financial blow was so severe that not all of the irrigation systems have been rehabilitated at this time. Livestock was lost, fences obliterated, stored feed and farming equipment washed away and roads rendered impassable for many days.

Dell Valley was isolated for 3 days. There was no travel to or from the area. except for helicopters from Fort Bliss, Texas, which set up temporary headquarters at Cornudas south of Dell City. When travel was resumed, Red Cross and Salvation Army personnel set up stations to aid families whose homes were flooded. Dell Valley was declared a major disaster area by the President and funds were allocated to relieve the suffering of the residents. The Agricultural Stabilization and Conservation Service provided funds to enable farm operators to rehabilitate irrigation systems.

The 1966 flood damages in the watershed were estimated at approximately $1,560,000.

The value of flood plain lands, marketwise, varies from $250 to $500 per acre depending upon location and soil capability.

The 1966 flood damages in the watershed were estimated at approximately $1,560,000.

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Water from 1966 flood was over 6 feet deep at this road crossing. Road damage is estimated to average $3,100 annually.

Floodwaters originating in this watershed contribute to damages to residences and commercial establishments in Dell City.

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Average annual crop and pasture damage is estimated at $118,000, in addition to other damages.

Damage to this concrete-lined irrigation ditch and other agricultural properties is estimated to average $106,000 annually.

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Under nonproject conditions, the estimated average annual direct monetary damage by floodwater is $228,479. Of this amount, $118,669 is crop and pasture; $106,639, other agricultural; and $3,171, road and bridge.

Erosion Damage

Upland erosion in the watershed is low. The estimated average annual rate of gross erosion is 0.30 acre-foot per square mile.

Flood plain erosion in the irrigated Dell Valley is high. Scouring resulting from the 1966 flood damaged 1,638 acres within the project area. Sheet scour on broad areas and channel-type scour in smaller areas removed the productive loamy surface soils and exposed less productive subsoil. In some areas the topsoil was removed to gravel, highly calcareous materials, and gypseous materials. Damages in terms of reduced productivity are distributed as follows: 752 acres, 10 percent; 491 acres, 20 percent; 284 acres, 40 percent; and 111 acres, 80 percent.

The average annual value of damage resulting in reduced production is estimated to be $12,583.

Sediment Damage

Sediment damages in the watershed are moderate. The major damage by sediment is associated with the floodwater damage outside the watershed in the urban area of Dell City. The silt and mud deposited in homes and businesses, and on equipment and machinery make cleanup operations very difficult after a flood. Sediment deposited on roads and highways, and in irrigation ditches requires cleanup and removal after flooding.

Deposits of coarse-grained materials on the flood plain soils damaged 487 acres of land in the 1966 flood. Most of the damaging materials are left in bar-like deposits from one-half to more than one foot deep. These deposits must be removed or smoothed down after flooding so that the land can be irrigated. Damage by the low fertility, sandy, and gravelly materials range from 10 to 20 percent in terms of reduced productivity. The average annual value of loss of productivity is estimated to be $1,399.

Problems Relating to Water Management

Approximately 39,000 acres of cropland and improved pasture are irrigated from the ground water under the Dell Valley. Of this, 17,073 acres are located within the project area. The water is pumped from a high yielding cavernous limestone aquifer at depths ranging from 40 to 200 feet. It is estimated that more than 100,000 acre-feet of water is pumped annually in Dell Valley to irrigate growing crops and to leach salts from the soil.

Ground water problems which are expected to affect future irrigation costs, yields, and cropping systems include increasing salinity of the water in the aquifer under Dell Valley and a decline in the water table. The water recharging the aquifer under the valley is only slightly saline, containing less than 1,500 parts per million dissolved solids. The ground water under

the valley, however, has increased in salinity because of contamination by salts leached from the permeable irrigated soils. This contamination is most pronounced in the center of the valley where the recharge water has less effect upon the salt concentration. A good example of this salinity increase is shown in tests made of water from a well located one mile east of Dell City. Tests of water from this well made in 1948, at the beginning of irrigation development, show a specific conductance (E.C.) of 2,210 (micromhos at 25° C). Subsequent tests of water from this well after 15 years of irrigation and again after 20 years show an increase to E.C. 5,650 in 1963 and to E.C. 6,100 in 1968. This indicates that the greatest increase in salinity occurred during the period immediately after irrigation development.

Ground water decline studies show that the water table has dropped about 25 feet since 1948. Approximately 3 feet of rise in the water table occurred from recharge by the 1966 flood. There is some indication that the annual rate of decline was slowing down before the 1966 flood. An average drop of about 1.7 feet per year is indicated during the 10-year period from 1950 to 1960. An average drop of 1.2 feet per year is indicated from 1960 to 1966 before recharge by the 1966 flood. Most of this decrease in rate of decline can probably be attributed to cessation of water outflow from the aquifer into the Dry Salt Lakes because of the lowered water table.

Continued lowering of the water table may create another source of salt pollution. Highly saline ground water in the sediments under the Dry Salt Lakes could possibly move into the Dell Valley aquifer as it continues to be lowered below the elevation of the water table of the lake sediments. The rate of movement through the fine-grained lake sediments would be slow.

Most of the crops grown in the Dell Valley are of medium to high salt tolerance. There are no indications, at present, that the water with the higher salt content has seriously affected production. This is attributed to the type of salts present in the water, the permeability of the irrigated soil, and probably also to the mineralogical makeup of the soil.

Ground water sources are utilized for municipal, domestic, and livestock purposes. Most of the ground water under the Dell Valley is too saline for municipal and domestic uses without treatment. Dell City uses the electrodialysis process for conversion of ground water containing about 2,500 parts per million dissolved solids to water with 600 parts per million dissolved solids. This plant serves the municipal needs of Dell City as well as the domestic needs for most of the surrounding area. The supply of ground water is more than adequate for future municipal needs; however, the problem of increasing salinity may increase treatment costs or require piping less saline water from wells which could be drilled north and northwest of the irrigated area.

Deep pit-type ponds or tanks are also used in the upland range areas for livestock water supply. These circular ponds are constructed in deep slowly permeable alluvial soils in the draws. Livestock water is also obtained from deep wells.

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PROJECTS OF OTHER AGENCIES

There are no project-type water resource developments of other agencies within the valley. However, the Hudspeth County Underground Water Conservation District No. 1, a subdivision of the state government, was formed to promote conservation of the underground water supply which is the lifeblood of the farming economy.

BASIS FOR PROJECT FORMULATION

A reconnaissance and preliminary investigation of the watershed were made by representatives of the Soil Conservation Service and the sponsoring local organizations to determine the location and severity of watershed problems. A map was prepared to show the location of the land being damaged by floodwater, erosion, and sediment. It was recognized that neither this watershed nor the adjoining Hitson, C&L and Washburn Draws watershed was a separate entity as such. Both are parts of a larger watershed and both contribute damaging floodwaters to a common plain. Land treatment and structural measures must be installed in both watersheds in order to achieve the desired damage reductions in either watershed. This interrelationship necessitated the planning of both watersheds concurrently. The works of improvement must be installed in the same manner in order that project objectives be achieved.

Meetings were held with the sponsors to discuss their problems, possible solutions, watershed resource development needs, and the formulation of project objectives. Initially the sponsors listed the following objectives:

1. Immediate establishment and maintenance of land treatment measures which contribute directly to watershed protection.

2. Provision for a level of flood protection which would allow the installation of planned water conservation and land treatment measures as well as reducing flood damages by 75 to 80 percent.

3. Stimulation of the economic development of the area as the result of project installation.

It was agreed that the objectives of the sponsors were reasonable and consistent with watershed resource development. Possible ways to meet the objectives of the sponsors were investigated. First, it was determined that land treatment measures alone would not reduce damages to an acceptable level. It was then determined that the only practical way to protect the intensively used flood plain from flood damages was to supplement the land treatment measures with needed structural measures that would control the floodwater and prevent flooding.

The location, number, design, and cost of structural measures were determined by the physical, topographic, and geologic conditions in the watershed. Other influencing factors were improvements, land use, and the location of damage areas.

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The land in the upper portion of the watershed is rangeland with topography generally suitable for floodwater retarding structures. The land use in the lower portion is predominantly cropland. Numerous roads and irrigation canals are located in the lower portion. The topography is unsuitable for floodwater retarding structures. These factors necessitated locating the floodwater retarding structures in the upper portion of the watershed.

Stream channel improvement and injection wells were considered as a means of controlling the principal spillway flows. Studies indicated that injection wells would be more economical and would enhance the water resources of the area.

The only other possible way to provide flood protection would be to construct floodways or concrete-lined channels to convey safely the floodwater through the valley. This alternate was not selected because of installation cost, numerous required modifications of improvements, operation and maintenance costs, required dedication of a large area of irrigated cropland to the project, and the foregoing of incidental recharge benefits.

This project as formulated, in combination with the project on the adjacent Hitson, C&L and Washburn Draws watershed, will meet the sponsors' objectives for watershed protection and flood prevention.

The sponsors were not interested in including additional storage for multiple-purpose use in any of the floodwater retarding structures.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The use of each acre of land within its capabilities and its treatment in accordance with its needs has long been accepted as one of the foundations for the building of a strong and free community, state, or nation. Sponsors of this project are keenly aware of this concept and deem the installation and maintenance of needed land treatment measures as essential.

Soil surveys have been completed for the Texas portion of the project. There are 660 acres of soil surveys needed in the New Mexico portion of the project. These acres will be surveyed during the first year of the installation period. With this accomplished, planning and application of needed measures can be achieved without interruption and on schedule.

In addition to effectively maintaining those land treatment measures already established (table 1A), additional soil and water conservation measures or combinations of measures to be applied on cropland include conservation cropping system, crop residue management, irrigation pipeline, irrigation ditch and canal lining, irrigation land leveling, irrigation water management, and structures for water control. Conservation measures which will be applied on pastureland include pasture and hayland planting, and pasture and hayland management. Fences, farm ponds, pipelines, and watering facilities will also

be constructed to enable operators to defer grazing and use rangeland properly. The application of these measures on grassland will result in increased and more dependable yields of nutritious grasses. The application of these measures, both on cropland and grassland, will improve both soil cover and condition. This improvement will reduce soil and water losses, assure proper functioning of the floodwater retarding structures, reduce flooding and help raise the income of operators of agricultural land.

Structural Measures

A system of three floodwater retarding structures will be installed to provide protection to the flood plain lands. The location of these planned structural measures is shown on the project map (figure 4).

Runoff from 73 percent of the watershed will be detained by the floodwater retarding structures. The storage capacity of the floodwater retarding structures is 13,238 acre-feet, of which 1,385 acre-feet are sediment storage and 11,853 acre feet are for floodwater detention storage. These structures will detain an average of 1.10 inches of runoff from the drainage area above them. In addition, an average of .13 inches of storage has been allocated for the expected 100-year accumulation of sediment. The principal spillway crest elevation for each structure will be set at the 50-year sediment capacity, but the principal spillway of floodwater retarding structure No. 1 will be ported at the 200 acre-foot capacity. The sediment pools of floodwater retarding structures Nos. 2 and 3 will be dry.

A combination of principal spillway capacity and retarding storage will assure that emergency spillways of floodwater retarding structures will have less than 1 percent chance of use at the end of their design life. The principal spillways will be of the drop inlet type with cantilever outlet.

Injection wells will be installed as appurtenances to the floodwater retarding structures to dispose of principal spillway discharges. Principal spillway discharges will be conveyed to the injection wells by concrete-lined channels. Well heads will be devised to remove foreign matter and unacceptable pollutive factors to safeguard the quality of water introduced into the aquifer. Additional studies to define the predictable water quality and details of well head treatment will be made prior to the time detail plans are submitted for approval. The wells will be cased through the alluvium. The depths of the wells will vary from 250 to 800 feet, depending upon the geologic conditions. The diameter of the wells will probably vary from 18 to 21 inches.

The permeability rates used in the design of the injection wells are based on rates found in tests of irrigation wells in Dell Valley. Pumping tests of

a number of productive irrigation wells during the early stages of development of the valley (1948-50) showed an average specific capacity of 100 gallons per minute per foot of drawdown. These early wells penetrated to depths of only 100 feet or so in water-bearing rock. Wells which did not penetrate enough porous rock for good production at these shallow depths were abandoned, thus requiring several test holes before a productive well was obtained. Deep oil test holes drilled in later years indicate that cavernous conditions exist to depths of several thousand feet in the Dell Valley area. Cleanout and deepening, since 1965, of old low production wells has proven that these wells can be improved by deepening. A productive well can be developed at almost any desired spot by continued drilling until the needed amount of porosity is obtained.

The surface of the water table under the Dell Valley is near elevation 3600 feet above mean sea level. About 200 feet of limestone occurs above the water table at Site 1; 150 feet at Site 2; and 100 feet at Site 3. The desired permeability for injection wells is expected to be obtained at depths of about 800 feet at Site 1; 400 feet at Site 2; and 250 feet at Site 3. The final depths of all wells and their location will be based on actual test drilling at each site.

All of the floodwater retarding structure sites are located on hard limestone bedrock. Deep deposits of alluvial silt (ML), clay (CL), gravel (GC, GM, and GP) occur in the valley at Sites 1 and 3. A relatively narrow alluvial valley occurs at Site 2. The principal spillways can be placed on hard limestone at all sites. Rock excavation in hard-jointed limestone will be required in the emergency spillways of all sites. The rock can be utilized as riprap to protect the embankment from wind erosion during dry periods and wave action during periods of impoundment. This rock and on-site gravel will also be used for construction of blanket drains on the permeable bedrock foundations.

Scattered sink holes in the uplands and logs of irrigation wells downstream indicate that cavernous conditions exist in the bedrock. Field investigations, however, indicate that there should not be any foundation problems resulting from cavernous conditions at any site.

It will be necessary to relocate a number of county roads and utility lines in order to install the structural measures. The county road at Site 1 will be closed and the utility lines will be relocated. The county roads and utility lines at Site 2 will be relocated.

All relocations, modifications, alterations or replacements of fixed improvements are land rights costs and will be borne by the sponsors.

Figures 2, 3, and 3A show structures which are typical of those planned for the watershed. Table 3 shows quantities and design features.

All applicable state laws will be complied with in the design and construction of structural measures, as well as those pertaining to storage, maintenance of quality, and use of water.

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Concrete-lined ditches increase irrigation efficiency and conserve water.

Rangeland will be deferred and used properly to reduce erosion. Proper use of the rangeland will also increase the amount of grasses available for grazing. Note the giant soap tree yucca.

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EXPLANATION OF INSTALLATION COSTS

The estimated total cost of installing the land treatment measures is $1,553,335 (table 1). This includes funds for Public Law 46 and Public Law 566 technical assistance to be provided by the Soil Conservation Service and cost sharing in the establishment of approved conservation measures under the Agricultural Conservation Program administered by the Agricultural Stabilization and Conservation Service. Included in the above sum is $49,465 of Public Law 566 funds to accelerate technical assistance in order that planning and application of needed land treatment measures included in this plan may be accomplished by the end of the 10-year installation period. The estimated cost for application of the various measures is based on current prices being paid by landowners and operators in the area.

The total installation cost of the structural measures is estimated to be $1,661,735. The Public Law 566 cost will be $1,622,275 and the local share will be $39,460.

The local cost includes $37,960 for land rights and $1,500 for project administration. The estimated value of land rights includes $700 for legal fees, $16,880 for value of easements, $9,900 for relocation of utility lines in floodwater retarding structure No. 1, $5,800 for relocation of a county road in floodwater retarding structure No. 2, and $4,680 for relocation of utility lines in floodwater retarding structure No. 2.

The estimated construction cost includes the engineer's estimate and a 10 percent allowance for contingencies. Major items considered were equipment mobilization, site preparation, core trench excavation, drop inlet principal spillways, earth fill, rock excavation and placement, and injection well construction. The unit cost for these items was based on actual cost of structural measures in similar areas modified to conditions found in this watershed.

Engineering and project administration costs are based on analysis of previous work in similar areas. Engineering costs consist of, but are not limited to, detailed surveys, geological investigations, laboratory reports, designs, and cartographic services. Project administration costs consist of construction inspection, contract administration, maintenance of Soil Conservation Service state office records and accounts, and Washington office and Engineering and Watershed Planning Unit costs.

Value of land, easements, and rights-of-way was estimated by representatives of the local sponsors and concurred in by the Soil Conservation Service. Portions of floodwater retarding structures No. 2 and No. 3 will be on federal and State of New Mexico land. All of floodwater retarding structure No. 1 and portions of floodwater retarding structures Nos. 2 and 3 will be on private land. Estimated costs for the land rights on federally owned land is $300.

The estimated cost for relocation of county roads was furnished by the county commissioners. The utility companies furnished the estimated costs for modifying their respective utility lines.

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The local costs for project administration include sponsors' costs related to contract administration, overhead and organizational administrative costs, and whatever construction inspection the sponsors desire to make at their own expense.

The estimated schedule of obligations for the 10-year installation period, covering installation of land treatment and structural measures, is as follows:

Fiscal Year	Measures	PL 566 Funds (dollars)	Other Funds (dollars)	Total (dollars)
1st	Land Treatment	4,946	150,387	155,333
2nd	Land Treatment	4,946	150,387	155,333
	Floodwater Retarding Structure No. 3	238,470	1,525	239,995
3rd	Land Treatment	4,946	150,387	155,333
	Floodwater Retarding Structure No. 2	601,960	17,120	619,080
4th	Land Treatment	4,946	150,387	155,333
	Floodwater Retarding Structure No. 1	781,845	20,815	802,660
5th	Land Treatment	4,946	150,387	155,333
6th	Land Treatment	4,947	150,387	155,334
7th	Land Treatment	4,947	150,387	155,334
8th	Land Treatment	4,947	150,387	155,334
9th	Land Treatment	4,947	150,387	155,334
10th	Land Treatment	4,947	150,387	155,334
TOTAL		1,671,740	1,543,330	3,215,070

EFFECTS OF WORKS OF IMPROVEMENT

The installation of land treatment and structural measures included in this watershed work plan and the watershed work plan for the adjacent Hitson, C&L and Washburn Draws watershed will benefit about 62 farm and ranch operators located within this watershed. About 50 irrigated farms will benefit directly from reduced flooding. Thirty-five of these are family-type farms employing less than 1½ man years of outside labor.

Damage to other agricultural property, estimated to average $106,639, will be reduced to $15,050 or 86 percent.

County road damage suffered during the 1966 flood. Although seldom so spectacular as the above, average annual damage to roads amounts to $3,171. Road and bridge damages will be reduced by 91 percent.

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Structural measures will control 91 percent and 94 percent, respectively, of the mountainous and upland areas of this watershed and the adjacent Hitson, C&L and Washburn Draws watershed.

The estimated average annual monetary damage within the watershed will be reduced from $266,707 to $38,616, or 86 percent.

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Structural measures will control 91 percent and 94 percent, respectively, of the mountainous and upland areas of this watershed and the adjacent Hitson, C&L and Washburn Draws watershed. The mountainous and upland area is the major source of damaging floodwater. These structural measures are designed to control the runoff from storms larger than the 100-year event.

The effect of the installation of all measures, both land treatment and structural, planned for this watershed and the adjoining Hitson, C&L, and Washburn Draws watershed upon flooding in this watershed is described below.

About 14,173 acres of valuable flood plain land will be protected by structural measures. This acreage includes 2,100 acres of benefited flood plain in Culp Draw. Average annual acres flooded will be reduced from 3,033 to 498, or 84 percent. The installation of all planned works of improvement will reduce average annual damages from $266,707 to $38,616, a reduction of 86 percent. Average annual floodwater damages will be reduced by 87 percent for crop and pasture, 86 percent for roads and bridges, and 86 percent for indirect damages. Flood plain scour damages will be reduced by 65 percent and sediment deposition damages will be reduced by 88 percent.

The flood damage remaining after installation of the project will result primarily from the runoff from the irrigated cropland below structural measures, roads, and miscellaneous areas.

Had the project been installed at the time of the disastrous 1966 flood, damages throughout the watershed would have amounted to only 23 percent of those which actually occurred.

The installation of the measures in this watershed will also provide flood protection to Dell City and the agricultural flood plain in the adjoining Hitson, C&L and Washburn Draws watershed.

Incidental ground water recharge from structural measures installed in this watershed is expected to average about 2,700 acre-feet annually. Seepage losses in the highly permeable pool areas of the structures and use of injection wells to dispose of released floodwaters will recharge the aquifer with water which normally flows into the Dry Salt Lakes and evaporates. This incidental recharge will reduce the annual rate of water level decline and will keep irrigation pumping costs from rising as rapidly as might otherwise be expected with the lowering water table.

In addition, the injected water will reduce the salinity level of the ground water in the vicinity of the structures and injection wells through the mixing of the fresh runoff waters with the more saline ground water.

The sediment pool of one floodwater retarding structure may provide some incidental recreation for watershed residents during periods of above normal rainfall. This may be in the form of boating, water skiing, and picnicking. However, the sponsors will discourage use of pool areas for recreation until sanitary facilities meeting state and local health requirements are provided.

About 279 acres of rangeland are located in sediment pools, dams, and spillways of floodwater retarding structures. No agricultural production is

expected from this acreage henceforth. Detention pools will require about 1,006 acres of rangeland. No loss in agricultrual production is expected in these pools, with the exception of 175 acres to be used for borrow. In fact, it may reasonably be expected that grass production will increase on the balance of the detention pool area, particularly in the upland portions where moisture is at a premium. It is possible that an additional 21 acres of borrow for dam construction may be required on flood plain rangeland outside of pool areas. If needed, no further grass production is expected from this area. An additional 9 acres of flood plain rangeland will be required for injection wells. This acreage will be fenced and will afford no grazing for livestock; however, it is expected that it will be used by wildlife such as quail, dove, etc.

The installation of structural measures will have no adverse effect on, nor will the structural measures be affected by, any known mineral resources within the watershed. There are no known archeological, paleontological,or historical features affected by this project.

The effects of works of improvement on fish and wildlife habitat are described by the Bureau of Sport Fisheries and Wildlife as follows:

> In general, the project would not significantly influence game population trends. Land treatment measures, such as conservation cropping systems and deferred and proper grazing use, would be beneficial to big game and upland game.

Secondary benefits will accrue to the trade area as a result of increased purchases from those supplying farm equipment, petroleum products, seeds, feeds, fertilizers, services, and other items needed by the family. The benefits from damage reduction will result in improved living standards for residents of the watershed. This improvement will be reflected in local support of schools and churches, both so important to the well-being of present and future generations. In addition to the monetary benefits, there are intangible benefits which will accrue. Residents will feel more secure knowing that the fruits of their labor and monetary investments are not so likely to be washed away at the whim of Mother Nature. They will also appreciate the fact that here is an excellent environment in which to rear their families. These benefits, although real and of utmost importance, have not been evaluated, nor have they been used for project justification in any way.

PROJECT BENEFITS

The estimated average annual monetary damage (table 5) within the watershed will be reduced from $266,707 to $38,616, or 86 percent. Crop and pasture damages will be reduced from $118,669 to $15,122, or 87 percent. Other agricultural damage, such as fence and livestock losses and damage to irrigation systems and other farm property, will be reduced from $106,639 to $15,050, or 86 percent. Road and bridge damages will be reduced from $3,171 to $300, or 91 percent. The deposition of damaging sediment upon flood plain soils, now occurring at the rate of $1,399 annually, will be reduced to $168 or

88 percent. Flood plain scour damages will be reduced from $12,583 to $4,465, or 65 percent. Indirect damages will be reduced from $24,246 to $3,511, or 86 percent.

Of the $228,093 damage reduction benefits expected in this watershed as the result of project installation, $121,448 will result from structures installed in this watershed, $1,127 from land treatment applied in this watershed, $104,025 from structures installed in adjacent Hitson, C&L and Washburn Draws watershed, and $1,493 from land treatment applied in that watershed.

In addition, structural measures installed in this watershed will produce $148,561 damage reduction benefits in adjacent Hitson, C&L and Washburn Draws watershed and land treatment applied in this watershed will produce $1,712 benefits in that watershed.

Structures in this watershed will also produce $37,842 in incidental ground water recharge benefits by helping maintain both water quality and water level in the aquifer being used for irrigation.

Incidental recreation benefits may accrue to residents of the watershed through the use of one of the floodwater retarding structure sediment pools for boating, water skiing, or picnicking during periods of above normal rainfall. No monetary evaluation has been made of these benefits due to limited rainfall and relatively high seepage losses.

Hudspeth and Otero Counties have not been designated as eligible for assistance under the Economic Development Act; therefore, no redevelopment benefits were considered.

Although not considered pertinent from a national viewpoint, secondary benefits stemming from the reduction in average annual damages and incidental ground water recharge will amount to $28,330 annually.

COMPARISON OF BENEFITS AND COSTS

The total average annual cost of structural measures (amortized total installation cost plus operation and maintenance) is $86,129. These measures are expected to produce average annual primary benefits of $307,851. The benefit-cost ratio without secondary benefits is 3.6 to 1.0. The ratio of total annual project benefits accruing to structural measures, $336,181, to the average annual cost of structural measures, $86,129, is 3.9 to 1.0 (table 6).

PROJECT INSTALLATION

The project installation period will be 10 years. The general sequence of installation is shown under the schedule of obligations, "Explanation of Installation Costs."

Planned land treatment (table 1) will be accomplished during the 10-year installation period.

Planned land treatment on private and state land will be accomplished by farm and ranch operators in cooperation with the Otero and the El Paso-Hudspeth Soil and Water Conservation Districts. Planned land treatment on federal land will be accomplished by the Bureau of Land Management, using their own technical resources.

The goal is the adequate treatment of 10,968 additional acres of cropland and 110,072 additional acres of grassland by the end of the installation period. This goal, in addition to the maintenance of those measures already applied, will be achieved as follows:

Land Use	Fiscal Year 1st (acres)	2nd (acres)	3rd (acres)	4th (acres)	5th (acres)	6th (acres)
Cropland	1,096	1,096	1,097	1,097	1,097	1,097
Grassland	11,007	11,007	11,007	11,007	11,007	11,007
TOTAL	12,103	12,103	12,104	12,104	12,104	12,104

Land Use	Fiscal Year - continued 7th (acres)	8th (acres)	9th (acres)	10th (acres)	Total (acres)
Cropland	1,097	1,097	1,097	1,097	10,968
Grassland	11,007	11,007	11,008	11,008	110,072
TOTAL	12,104	12,104	12,105	12,105	121,040

The Bureau of Land Management concurs in its part in carrying out this plan. Land treatment measures installed on BLM lands, which consists of proper range use, will be based on allotment management plans.

The governing bodies of the soil and water conservation districts will assume aggressive leadership in accelerating the land treatment program now being applied. The installation of land treatment measures which will benefit wildlife will be encouraged at every opportunity. Landowners will be encouraged to consult the Texas Parks and Wildlife Department or the New Mexico Department of Game and Fish regarding the feasibility of installing wildlife watering devices on the uplands of the watershed.

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The Soil Conservation Service will provide additional technical assistance to the soil and water conservation districts to accelerate the planning and application of soil, plant, and water conservation measures.

The Agricultural Stabilization and Conservation Service will provide financial assistance for the application of those measures which will accomplish the conservation objectives in the shortest possible time. The Extension Service will assist in the educational phase of the program by holding local farm meetings, preparing press, radio, and television releases, and using other methods of getting information to landowners and operators in the watershed. Soil and water conservation loans available through the Farmers Home Administration will be given special emphasis. Present FHA clients in the watershed will be encouraged to cooperate in the program.

Injection wells are appurtenances and will be constructed simultaneously with the floodwater retarding structures with which they are associated.

Technical assistance will be provided by the Soil Conservation Service in the preparation of plans and specifications, construction inspection, preparation of contract payment estimates, final inspection, execution of certificate of completion, and related tasks necessary to install the structural measures.

The Soil Conservation Service, in compliance with the request made by the sponsors, will provide the necessary administrative and clerical personnel, facilities, and supplies to advertise, award, and administer contracts, and will be the contracting agency.

The Otero County Commission, New Mexico, and the Hudspeth County Commissioners Court, Texas, have the right of eminent domain under applicable state laws and have the financial resources necessary to fulfill their responsibilities.

The Otero County Commission will take the following actions for floodwater retarding structures Nos. 2 and 3:

1. Obtain all land rights needed legally for construction and take related land rights action conforming to Service policy requirements.

2. Determine the legal adequacy of land rights and use its power of eminent domain to obtain all land rights not donated.

3. Be responsible for working with the Service during construction of works of improvement. They will designate in writing an individual to serve as liaison between the commission and the Service.

4. Provide for the relocation or modification of utility lines and systems, roads, and privately owned improvements as necessary for installation of structural measures.

5. Submit all plans and specifications for the floodwater retarding structures to the New Mexico State Engineer for filing and approval

and otherwise comply with applicable state laws before invitations to bid are advertised by the Soil Conservation Service.

The Hudspeth County Commissioners Court will take the following action concerning floodwater retarding structure No. 1:

1. Obtain all land rights needed legally for construction and take related land rights action conforming to Service policy requirements.

2. Determine the legal adequacy of land rights and use its power of eminent domain to obtain all land rights not donated.

3. Be responsible for working with the Service during construction of works of improvement. They will designate in writing an individual to serve as liaison between the court and the Service.

4. Provide for the relocation or modification of utility lines and systems, roads, and privately owned improvements necessary for installation of structural measures.

The structural measures will be installed pursuant to the following conditions:

1. The requirements for land treatment in the drainage area above the floodwater retarding structures have been met.

2. All land rights have been obtained for all structural measures, or the sponsors have furnished a written statement to the effect that they have the means of securing land rights and the exact date by which all land rights will have been obtained. Following is a schedule, by 6-month periods, for obtaining needed land rights:

1st 6-month period	Floodwater retarding structure No. 1
2nd 6-month period	Floodwater retarding structure No. 3
3rd 6-month period	Floodwater retarding structure No. 2

3. Utilities, such as power lines and telephone lines, have been relocated or permission granted to inundate the properties involved.

4. The county road affected by floodwater retarding structure No. 1 has been closed and the county roads affected by floodwater retarding structure No. 2 have been relocated.

5. Project agreements have been executed.

6. Operation and maintenance agreements have been executed.

7. Public Law 566 funds are available.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement described in this work plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended.

The cost of installing the needed land treatment measures on private and state lands during the 10-year installation period will be borne by the landowners and operators of the land on which these measures are installed. The cost of installing the needed land treatment measures on federal land will be borne by the Bureau of Land Management.

The Agricultural Stabilization and Conservation Service will provide financial assistance for the installation of those land treatment measures which are eligible for this assistance. The Farmers Home Administration, local banks, and other lending institutions can arrange financing for the landowners and operators' share of the cost.

The Soil Conservation Service will provide funds in the amount of $99,939 to finance the cost of technical assistance in planning and application of the land treatment measures. This consists of $49,465 of Public Law 566 funds and $50,474 to be provided from Public Law 46 funds (table 1).

It is anticipated that 80 percent of the easements to be acquired will be donated. Out-of-pocket costs for land rights and project administration are estimated to be $13,000.

The Hudspeth County Commissioners Court will provide the local share of the cost of installing floodwater retarding structures Nos. 1 and 2. The Otero County Commission will provide the local share of the cost of installing floodwater retarding structure No. 3. Existing tax sources are adequate for financing the share of project installation costs to be borne by the local interests.

Financial and other assistance to be furnished by the Soil Conservation Service is contingent on the appropriation of funds for this purpose. In addition, all prerequisite conditions will be met before federal funds will be made available for the installation of structural measures.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures on private and state land will be maintained by the landowners and operators of farms and ranches on which the measures are installed under agreements with the Otero and the El Paso-Hudspeth Soil and Water Conservation Districts. Representatives of the districts will make periodic inspections of the completed land treatment measures to determine maintenance needs. The Bureau of Land Management will be responsible for the maintenance of land treatment measures installed on federal land.

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The Otero County Commission will be responsible for the operation of floodwater retarding structures Nos. 2 and 3 and the maintenance of floodwater retarding structure No. 3.

The Hudspeth County Commissioners Court will be responsible for operation of floodwater retarding structure No. 1 and the maintenance of floodwater retarding structures Nos. 1 and 2.

The counties will pay the cost of maintenance out of existing tax revenues. The estimated average annual cost of operation and maintenance is $400. The estimated average annual cost of operation and maintenance is based on adjusted normalized prices. Maintenance is expected to consist of, but is not limited to, control of undesirable vegetation, debris removal, and maintenance of earth fills, spillways and injection wells.

The Service and the sponsors will make a joint inspection annually, or after unusually severe floods, or in the event of other unusual conditions that may adversely affect the works of improvement, for three years following installation of each structure. Inspection after the third year will be made annually by the sponsors. The Service will participate in annual inspections as often as it elects to do so after the third year. Inspection items are those items which may need maintenance. For the floodwater retarding structures, items of inspection will include, but will not be limited to, condition of the principal spillways, earth fills, emergency spillways, injection wells, fences, gates, and vegetative growth in reservoirs.

Upon acceptance of completed works of improvement from the contractor, the counties will be totally responsible for all maintenance. Maintenance will be performed promptly as the need arises.

The Soil Conservation Service, through the soil and water conservation districts, will participate in operation and maintenance only to the extent of furnishing technical assistance to aid in inspections and technical guidance and information necessary for the operation and maintenance program.

Provisions will be made for free access of representatives of the sponsoring local organizations and federal representatives to inspect and provide for maintenance for all structural measures and their appurtenances at any time.

The counties will prepare a report of all maintenance inspections. A copy of this report will be submitted to the Service representative. The counties will keep summary control records in support of proper maintenance having been performed on these works of improvement.

An operation and maintenance agreement will be executed by the parties hereto prior to signing of the initial project agreement and the issuance of invitations to bid on construction of the structural measures. The agreement will set forth specific details on procedure in line with recognized assignments of responsibility.

The necessary maintenance work will be accomplished either by contract, force account, or equipment owned by the respective counties.

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TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Cornudas, North, and Culp Draws Watershed, Texas and New Mexico

Installation Cost Item	Unit	Number To Be Applied				Estimated Cost (Dollars) 1/										
						Public Law 566 Funds				Other Funds				Total		
		Federal	Non-Federal			Federal	Non-Federal Land			Federal	Non-Federal Land					
		Land	New Mexico	Texas	Total	Land	New Mexico	Texas	Total	Land	New Mexico	Texas	Total	New Mexico	Texas	Watershed
LAND TREATMENT																
Soil Conservation Service																
Cropland	Acre	-	2,272	8,696	10,968	-	-	-	-	-	211,415	872,546	1,083,961	211,415	872,546	1,083,961
Grassland	Acre	-	42,673	17,399	60,072	-	-	-	-	-	125,327	48,356	173,683	125,327	48,356	173,683
Technical Assistance						-	26,497	22,968	49,465	-	12,797	37,677	50,474	39,294	60,645	99,939
SCS Subtotal						-	26,497	22,968	49,465	-	349,539	958,579	1,308,118	376,036	981,547	1,357,583
Bureau of Land Management																
Grassland	Acre	50,000	-	-	50,000	-	-	-	-	195,752	-	-	195,752	195,752	-	195,752
BLM Subtotal						-	-	-	-	195,752	-	-	195,752	195,752	-	195,752
TOTAL LAND TREATMENT						-	26,497	22,968	49,465	195,752	349,539	958,579	1,503,870	571,788	981,547	1,553,335
STRUCTURAL MEASURES																
Construction																
Soil Conservation Service																
Floodwater Retarding Structures	No.	2/	2/	1	3	438,329	260,151	652,960	1,351,440	-	-	-	-	698,480	652,960	1,351,440
SCS Subtotal						438,329	260,151	652,960	1,351,440	-	-	-	-	698,480	652,960	1,351,440
Subtotal - Construction						438,329	260,151	652,960	1,351,440	-	-	-	-	698,480	652,960	1,351,440
Engineering Services																
Soil Conservation Service																
Floodwater Retarding Structures	No.	2/	2/	1	3	23,744	14,176	34,145	72,065	-	-	-	-	37,920	34,145	72,065
Subtotal - Engineering						23,744	14,176	34,145	72,065	-	-	-	-	37,920	34,145	72,065
Project Administration																
Soil Conservation Service																
Construction Inspection						27,742	16,698	39,180	83,620	-	-	-	-	44,440	39,180	83,620
Other						37,387	22,203	55,560	115,150	660	340	500	1,500	60,590	56,060	116,650
Subtotal - Administration						65,129	38,901	94,740	198,770	660	340	500	1,500	105,030	95,240	200,270
Other Costs																
Land Rights						-	-	-	-	300	17,345	20,315	37,960	17,645	20,315	37,960
Subtotal - Other						-	-	-	-	300	17,345	20,315	37,960	17,645	20,315	37,960
TOTAL STRUCTURAL MEASURES						527,202	313,228	781,845	1,622,275	960	17,685	20,815	39,460	859,075	802,660	1,661,735
TOTAL PROJECT						527,202	339,725	804,813	1,671,740	196,712	367,224	979,394	1,543,330	1,430,863	1,784,207	3,215,070
SUMMARY																
Subtotal - SCS						527,202	339,725	804,813	1,671,740	960	367,224	979,394	1,347,578	1,235,111	1,784,207	3,019,318
Subtotal - BLM						-	-	-	-	195,752	-	-	195,752	195,752	-	195,752
TOTAL PROJECT						527,202	339,725	804,813	1,671,740	196,712	367,224	979,394	1,543,330	1,430,863	1,784,207	3,215,070

1/ Price Base: 1969

2/ Floodwater retarding structures Nos. 2 and 3 will be constructed partially on federal land.

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT 1/

Cornudas, North and Culp Draws Watershed, Texas, and New Mexico

Measure	Unit	Applied to Date: Non-Federal Land: New Mexico	Applied to Date: Non-Federal Land: Texas	Applied to Date: Total	Total Cost (Dollars) 2/: Non-Federal Land: New Mexico	Total Cost (Dollars) 2/: Non-Federal Land: Texas	Total Cost (Dollars) 2/: Total
LAND TREATMENT							
Conservation Cropping System	Acre	1,900	9,764	11,664	950	4,882	5,832
Crop Residue Management	Acre	1,855	6,423	8,278	5,565	19,269	24,834
Irrigation Pipeline	Foot	11,330	44,905	56,235	28,325	112,262	140,587
Irrigation Ditch and Canal Lining	Foot	20,900	217,435	238,335	62,700	543,588	606,288
Irrigation Land Leveling	Acre	8	695	703	400	34,750	35,150
Irrigation System, Surface and Subsurface	No.	11	3	14	38,500	10,500	49,000
Irrigation Water Management	Acre	1,183	1,085	2,268	3,549	3,255	6,804
Structure for Water Control	No.	-	2	2	-	1,600	1,600
Well	No.	38	-	38	198,000	-	198,000
Diversion	Foot	9,500	-	9,500	6,450	-	6,450
Pond	No.	6	4	10	9,000	6,000	15,000
Pasture and Hayland Planting	Acre	200	76	276	7,000	2,660	9,660
Pasture and Hayland Management	Acre	100	-	100	500	-	500
Proper Grazing Use	Acre	31,100	1,335	32,435	1,555	67	1,622
Deferred Grazing	Acre	25,800	1,335	27,135	3,870	200	4,070
Pipeline	Foot	12,945	-	12,945	3,884	-	3,884
Trough or Tank	No.	8	-	8	4,000	-	4,000
Grade Stabilization Structure	No.	2	-	2	200	-	200
TOTAL LAND TREATMENT					374,448	739,033	1,113,481

1/ Applies to non-federal land. Data on 50,000 acres of rangeland administered by Bureau of Land Management not available.
2/ Price Base: 1969

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Cornudas, North and Culp Draws Watershed, Texas and New Mexico
(Dollars) 1/

Item	Installation Cost - PL 566 Funds			Installation Cost - Other Funds		Total Installation Cost
	Construction	Engineering	Total PL 566	Land Rights	Total Other	
Floodwater Retarding Structures						
1	652,960	34,145	687,105	20,315	20,315	707,420
2	502,440	26,620	529,060	16,620	16,620	545,680
3	196,040	11,300	207,340	1,025	1,025	208,365
Subtotal	1,351,440	72,065	1,423,505	37,960	37,960	1,461,465
Project Administration	xxx	xxx	198,770	xxx	1,500	200,270
GRAND TOTAL	1,351,440	72,065	1,622,275	2/ 37,960	39,460	1,661,735

1/ Price Base: 1969
2/ Includes $700 for legal fees and $20,380 for relocation or modification of fixed improvements.

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TABLE 3 - STRUCTURE DATA - FLOODWATER RETARDING STRUCTURES
Cornudas, North and Culp Draws Watershed, Texas and New Mexico

Item	Unit	Structure Number 1	1/2	1/3	Total
Class of Structure		a	2/a	2/a	xxx
Drainage Area	Sq. Mi.	97.14	92.85	12.16	202.15
Curve No. (1-day)(AMC II)		81	80	85	xxx
Tc	Hrs.	3.81	3.63	1.13	xxx
Elevation Top of Dam	Ft.	3848.8	3811.5	3757.9	xxx
Elevation Crest Emergency Spillway	Ft.	3838.5	3794.5	3745.0	xxx
Elevation Crest Principal Spillway	Ft.	3818.0	3769.5	3726.0	xxx
Elevation Crest Lowest Ungated Outlet	Ft.	3817.0	3759.0	3720.0	xxx
Maximum Height of Dam	Ft.	40	53	40	xxx
Volume of Fill	Cu. Yds.	1,229,200	608,000	334,000	2,171,200
Total Capacity	Ac. Ft.	6,225	5,800	1,213	13,238
Sediment Pool (Lowest Ungated Outlet)	Ac. Ft.	200	0	0	200
Sediment Submerged 1st 50 Years	Ac. Ft.	291	265	24	580
Sediment Submerged 2nd 50 Years	Ac. Ft.	284	258	24	566
Sediment Aerated	Ac. Ft.	120	109	10	239
Retarding	Ac. Ft.	5,530	5,168	1,155	11,853
Surface Area					
Sediment Pool (Lowest Ungated Outlet)	Acres	82	0	0	82
Sediment Pool (Principal Spillway Crest)	Acres	102	48	13	163
Retarding Pool	Acres	485	545	119	1,149
Principal Spillway					
Rainfall Volume (Areal)(1-day)	In.	4.29	4.30	4.46	xxx
Rainfall Volume (Areal)(10-day)	In.	6.95	6.96	7.05	xxx
Runoff Volume (10-day)	In.	1.17	1.14	3.87	xxx
Capacity (Maximum)	C.F.S.	52	52	37	xxx
Frequency Operation - Emer. Spillway	% Chance	0.7	0.7	0.8	xxx
Size of Conduit	In.	24	24	24	xxx
Emergency Spillway					
Rainfall Volume (ESH)(Areal)	In.	1.91	1.94	3.45	xxx
Runoff Volume (ESH)	In.	.55	.53	1.97	xxx
Type		Rock	Rock	Rock	xxx
Bottom Width	Ft.	500	500	500	xxx
Velocity of Flow (V_e)	Ft./Sec.	0	0	5.2	xxx
Slope of Exit Channel	Ft./Ft.	.025	.023	.068	xxx
Maximum Water Surface Elevation	Ft.	-	-	3746.7	xxx
Freeboard					
Rainfall Volume (FH)(Areal)	In.	6.65	13.90	24.63	xxx
Runoff Volume (FH)	In.	4.48	11.30	22.50	xxx
Maximum Water Surface Elevation	Ft.	3848.8	3811.5	3757.9	xxx
Capacity Equivalents					
Sediment Volume	In.	0.135	0.127	0.089	xxx
Water Supply Volume	In.	-	-	-	xxx
Retarding Volume	In.	1.070	1.039	1.780	xxx

1/ Structures are located in New Mexico.
2/ Class "a" structure with emergency spillway designed to convey the probable maximum precipitation required by State Engineer, New Mexico.

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TABLE 4 - ANNUAL COST

Cornudas, North and Culp Draws Watershed, Texas and New Mexico

(Dollars)[1/]

Evaluation Unit	Amortization of Installation Cost	Operation and Maintenance Cost	Total
Cornudas and North Draws			
2 Floodwater Retarding Structures	64,647	268	64,915
Culp Draw			
1 Floodwater Retarding Structure	10,750	132	10,882
Project Administration	10,332	xxx	10,332
GRAND TOTAL	85,729	400	86,129

1/ Price Base: 1969 prices amortized for 100 years at 5.125 percent. Operation and maintenance at adjusted normalized prices, April 1966.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Cornudas, North and Culp Draws Watershed, Texas and New Mexico
(Dollars)[1/]

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
Floodwater			
Crop and Pasture	118,669	15,122	103,547
Other Agricultural	106,639	15,050	91,589
Non-Agricultural			
Road and Bridge	3,171	300	2,871
Subtotal	228,479	30,472	198,007
Sediment			
Deposition	1,399	168	1,231
Erosion			
Flood Plain Scour	12,583	4,465	8,118
Indirect	24,246	3,511	20,737
TOTAL WATERSHED	266,707	38,616	228,093
Outside Project Area[2/]		plus	148,561
Benefits Allocated to Structural Measures To Be Installed in Hitson, C&L and Washburn Draws Watershed		minus	104,025
TOTAL			272,629

1/ Price Base: Adjusted normalized prices, April 1966.
2/ Damage reduction benefits in Hitson, C&L and Washburn Draws watershed which will result from the installation of planned project in this watershed.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Cornudas, North and Culp Draws Watershed, Texas and New Mexico

(Dollars)[1/]

Evaluation Unit	Average Annual Benefits				Average Annual Cost[3/]	Benefit-Cost Ratio
	Damage Reduction[2/]	Incidental Ground Water Recharge	Secondary	Total		
Cornudas and North Draws						
2 Floodwater Retarding Structures	227,132	35,571	24,205	286,908	64,915	4.4:1.0
Culp Draw						
1 Floodwater Retarding Structure	42,877	2,271	4,125	49,273	10,882	4.5:1.0
Project Administration	xxx	xxx	xxx	xxx	10,332	xxx
GRAND TOTAL[4/]	270,009	37,842	[5/]28,330	336,181	86,129	3.9:1.0

1/ Annual benefits and operation and maintenance costs based on adjusted normalized prices, April 1966; construction costs based on 1969 prices.

2/ Includes $148,561 damage reduction benefits in Hitson, C&L and Washburn Draws watershed accruing to structural measures in this watershed.

3/ From table 4.

4/ In addition, it is estimated that land treatment installed in this watershed and in the Hitson, C&L and Washburn Draws watershed will provide $2,620 damage reduction benefits in the project area.

5/ Resulting from $14,825 secondary benefits from damage reduction and incidental ground water recharge in Cornudas, North and Culp Draws watershed and $13,505 secondary benefits from damage reduction in Hitson, C&L and Washburn Draws watershed.

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INVESTIGATIONS AND ANALYSES

Land Use and Treatment

The status of land treatment measures for non-federal lands in the watershed was developed by directors of the Otero and the El Paso-Hudspeth Soil and Water Conservation Districts with assistance from personnel of the Soil Conservation Service Work Units located in Alamogordo, New Mexico, and Dell City, Texas. Representative basic soil and water conservation plans were analyzed both in the office and on the land. These findings were expanded for the entire watershed. The Bureau of Land Management furnished the status of land treatment measures for the federal lands in the watershed.

This analysis provided pertinent data on total conservation needs, accomplishments to date, and remaining needs, and was used in the establishment of priorities for planning, application, and maintenance of needed land treatment measures.

The need for funds for accelerated technical assistance represents the difference in the amount of funds now being expended and those which will be required in order to meet the project goal of the application of 80 percent of all needed land treatment by the end of the 10-year installation period.

Engineering Investigations

The procedures used to determine the most feasible plan of structural measures to meet the objectives of the sponsoring local organizations that could not be accomplished by land treatment measures were as follows:

1. A base map of the watershed was prepared showing watershed boundary, drainage pattern, systems of roads, utility lines, and other pertinent information.

2. Possible sites for structural measures were located by stereoscopic study of aerial photographs supplemented by field investigations. Two sites were considered on Cornudas Draw and one site each was located on North and Culp Draws for possible floodwater retarding structures. The upper site on Cornudas Draw was dropped from consideration after preliminary investigations. The three remaining sites were recommended to the sponsors for further study.

3. Surveys - Engineering surveys were made after preliminary agreement was reached with the sponsoring local organizations on location of structural measures to be studied. The ownership and property lines of the land involved were furnished by the sponsors.

    a. Vertical control - Existing U. S. Geological Survey and U. S. Coast & Geodetic Survey bench marks were supplemented with temporary bench marks set at strategic locations for use in making surveys.

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b. Floodwater retarding structures - Field surveys were made in two stages. First, topographic maps of the three sites selected for further study were prepared. Roads, utility lines, and miscellaneous improvements located within the reservoir areas were surveyed. Second, after preliminary designs were made and layouts of the floodwater retarding structures that would be feasible to install were reviewed and accepted by the sponsors, detailed topographic surveys of the emergency spillway areas were made. A profile survey of the centerline of each dam site was made. These surveys provided the data necessary to determine the most economical design, to make estimates of the installation cost, and to prepare land rights work maps.

4. Designs - Design of the floodwater retarding structures was a continuous process during work plan development. Designs were made as information was collected and surveys completed.

Criteria used in designs equal or exceed that required in Engineering Memorandum-27 (Rev). Structures were classified for design criteria, depending upon the damage that would result from an instantaneous breach of the dam. Principal spillway, emergency spillway, and freeboard hydrographs were developed and flood routed to determine the elevation of emergency spillway, dimensions of emergency spillway, and elevation of top of dam for each floodwater retarding structure. All floodwater retarding structures meet the design criteria of the state in which they are to be constructed. Injection wells were planned as appurtenances to the floodwater retarding structures to dispose of the principal spillway discharges. The final design and location of the wells will be made during the operations stage.

Lower than normal release rates were selected to reduce the cost of injection wells. Studies were made to determine if the selected release rates would adversely affect the floodwater retarding structures.

Operation studies for the period 1941-1960 were made of floodwater retarding structures Nos. 1 and 2:

a. Considering evaporation and .5 c.s.m. release through principal spillway.

b. Considering evaporation, seepage from the total pool area, and .5 c.s.m. release through principal spillway.

c. Considering evaporation, seepage from the detention pool area only, and .5 c.s.m. release through the principal spillway.

d. Considering evaporation and seepage from the detention pool area only.

Seepage losses were estimated based on studies made of a large farm pond in the area. The pool levels were checked at regular intervals in August 1968 after the pond had been partially filled. The seepage rates were determined by subtracting the estimated evaporation losses from the total losses. The rates were extremely high in the upper stages where fractured limestone is exposed. Rates were lower when the pool covered only the alluvium.

The lower seepage rate was used in Darcy's formula to determine the coefficient of permeability. The result was .035, which, according to Standard Drawing No. ES-1019, would be associated with the lowest coefficient expected with poorly graded sand and gravelly sand with little or no fines. A conservative coefficient of permeability (.01) was used in the operation studies where seepage losses were considered.

These studies indicated that for the period studied, none of the emergency spillways would have functioned.

5. Cost estimates - Construction costs were based on unit prices being expended at similar sites, Soil Conservation Service experience, and values furnished by local organizations and utility companies.

   Evaluation of the estimated cost of installing different combinations of floodwater retarding structures was made to determine the least costly system to meet project objectives. Alternate cost estimates indicated that the three floodwater retarding structures included in the plan were the most feasible means studied of controlling the floodwater from the uplands.

   Each dam was analyzed to determine the least costly combination of emergency spillways and embankments. Cost estimates were made to determine the most feasible means of disposing of the principal spillway discharges. Investigations indicated that injection wells would accomplish this at less cost than stream channel improvement.

   Annual maintenance cost for each structure was based on the estimated expense involved in annual inspections, removal of obstructions from emergency spillways and injection wells, and fence repairs.

Hydraulic and Hydrologic Investigations

The following steps were taken as part of the hydraulic and hydrologic investigations:

1. Basic meteorologic and hydrologic data were obtained from the Weather Bureau, Environmental Science Services Administration, U. S. Department of Commerce. There are no Weather Bureau stations in the watershed. A tabulation was made of Weather Bureau station records in the vicinity of the watershed, and local records in and near the watershed. Orographic influences on rainfall were considered throughout the watershed.

Rainfall frequency data for the watershed were obtained from Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas for the United States." (Frequency data were supplemented with information prepared by Special Studies Branch, Office of Hydrology, Weather Bureau, for the Soil Conservation Service, dated June 1967.)

2. The present hydrologic conditions were determined from about a 10 percent sampling of soil and cover conditions. Areas showing significant variations in hydrologic soil groupings and cover conditions were delineated on a watershed base map. The with project hydrologic conditions were determined by considering the effects of treatment that can be expected during the installation period.

3. The area subject to damage from flooding was determined by studies of aerial photos, U. S. Geological Survey quadrangle sheets, and field interviews with local residents.

   A map of the area flooded by the August 1966 flood was prepared by the local residents. Elevations of the high water marks from the 1966 flood were established by field surveys. Numerous photographs of damages from the 1966 flood were furnished by the local people. Information concerning past floods and flooding was obtained from local residents. These investigations were used to determine the area that would be flooded by the selected frequency floods under each of the following conditions:

   a. The without project conditions, using the present soil cover complex number.

   b. The with project conditions of the watershed, using various systems of structural measures with the future soil cover complex number.

4. Reservoir operation studies were completed to determine the feasibility of meeting recreation demands in one of the proposed floodwater retarding structures. The results of the studies indicated that the recreation demands could not be met because of excessive evaporation and seepage from the structures. Reservoir evaporation rates were obtained from Texas Board of Water Engineers Bulletin 6006, "Monthly Reservoir Evaporation Rates for Texas," and were adjusted to reflect the effect of solar radiation, wind, dew point, and air temperature in accordance with U. S. Weather Bureau Technical Paper No. 37. Rainfall records for the Weather Bureau station at Cornudas Service Station were used for the studies.

Sedimentation Investigations

Sedimentation investigations were made as follows:

1. The 100-year sediment storage requirements for all floodwater retarding structures were determined. The following detailed field studies were made:

a. Gross erosion rates for the watershed were obtained from data developed on areas having similar soils, cover, and topographic features in the Hitson, C&L and Washburn Draws watershed. These data were based on a 10 percent sampling of the uplands to obtain soil and cover conditions within topographically similar areas. The Musgrave equation was used to arrive at estimated gross erosion rates within each of the areas. The Musgrave data were checked against other data developed from a sediment survey on a relatively new ranch pond.

b. The estimated gross erosion expected to occur within the drainage area of each structure was adjusted for expected delivery and trap efficiency of the reservoir. The sediment delivery ratio used was based on the relief-length ratio of the drainage area of each structure and trap efficiency was estimated to be 90 percent.

c. Allowances for differences in density of soil and sediment are based on volume weights of 86 pounds per cubic foot for sediment. The sediment weight reflects expected compaction by aeration of the sediment in all pools because of low runoff, high evaporation, and high permeability rates of the soils in the pools.

d. The allocation of sediment in the structure pools is as follows:

Period of Deposition	Pool	Condition	Percent
First 50 years	Sediment	Submerged	80
	Detention	Aerated	20
Second 50 years	Sediment	Submerged	80
	Detention	Aerated	20

2. Sediment and scour damage investigations were made by the field mapping method of mapping the damaged soils within a 20 percent sample of the flood plain. A flood damage map prepared on a photomosaic by Soil Conservation Service personnel at Dell City after the severe 1966 flood was used to pinpoint damage areas and assess amount of damage to the soil. Evaluations of soil productivity losses caused by scouring of the topsoil and deposition of low productivity materials (mainly sand and gravel) were made on the basis of information obtained by interview of landowners and by field observations of crop production in the damaged areas.

Geologic Investigations

Floodwater Retarding Structure Site Investigations

Preliminary geologic dam site investigations were made and reports prepared for each of the floodwater retarding structure sites. These investigations include studies of valley slopes, alluvium, and exposed geologic formations.

All of the planned floodwater retarding structures are located on hard Permian bedrock of the Victorio Peak Limestone formation (Permian age). The beds show considerable jointing and have high rates of permeability. Faulting occurs in the vicinity of the site on Culp Draw. Site 2 on North Draw has a very narrow and shallow alluvial filled valley. Wide and deep alluvial valleys occur at the other two sites. Borrow materials for Sites 1 and 3 can be obtained from the pool areas upstream of the dam. Site 2 may require additional borrow from areas downstream of the dam.

Detailed investigations, including exploration with core drilling equipment, will be made at each floodwater retarding structure site prior to construction to determine the suitability and methods of handling foundation and embankment materials.

Ground Water and Injection Well Investigations

Information on the source, supply, quality, and water level fluctuations of the ground water used for irrigation in the Dell Valley was obtained from the following sources:

1. Texas Water Commission, 1965, Reconnaissance investigations of the ground water resources of the Rio Grande Basin, Texas, Bull. 6502.

2. Texas Board of Water Engineers, 1950, Development of ground water for irrigation in the Dell City area, Hudspeth County, Texas, Bull. 5004.

3. Texas Agricultural Experiment Station, 1959, Some relations among irrigation water quality, soil characteristics and management practices in the Trans-Pecos area, MP-373.

4. Texas Water Commission, 1964, Water levels and chemical analyses from observation wells in the Dell City area, Hudspeth and Culberson Counties, Texas, 1948 through 1964, Circ. No. 64-01.

5. Unpublished water measurements and quality tests were obtained for 1966, 1967, and 1968 from the U. S. Geological Survey at El Paso, Texas. Water quality data for 1968 were obtained from the district conservationist at Dell City, Texas.

6. Well logs on recently completed deep irrigation wells were obtained from the C&L Ranch and information on caverns and permeability of limestone above the water table from local well drillers.

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Information relative to ground water and geologic conditions was studied and summarized for use in planning and designing injection wells and for use in making economic evaluations relating to water level declines and water salinity problems in cropping systems. Incidental recharge from installation of the wells and losses from the pools into the aquifer is estimated to amount to 2,700 acre-feet annually. This estimate is based on average annual runoff for the watershed. This recharge will reduce rate of water table decline and effect an improvement in water quality through dilution of the slightly saline ground water.

Economic Investigations

The economic evaluation of the project was made as follows:

1. Landowners and operators of flood plain lands were interviewed concerning their experiences with floodwaters on their farms. Information was also obtained concerning land use and crop distribution, planting dates, harvesting dates, normal crop yields, cultural practices, historical data on flooding and the resultant damages to crops, pasture, other agricultural property, and roads and bridges. Land use and crop distribution were then verified by field inspection and mapping. These schedules were taken from operators of about one-third of the flood plain lands.

2. County commissioners and Texas Highway Department personnel were interviewed concerning floodwater damages to roads and bridges for specific floods.

3. Studies of water quality tests run on irrigation wells throughout the irrigated area indicate that salinity is increasing. This increase was taken into account in the project of crop distribution and yields over the 100-year evaluation period.

4. Average annual crop and pasture damage estimates were made, as were all other estimates, by use of the frequency method. Damages per acre flooded were based on the projected composite acre damageable value at adjusted normalized prices (1966), depth of flooding, and percent chance of the flooding occurring during any given season.

5. Average annual other agricultural damage estimates were based on actual experiences of farm operators regarding damage to irrigation systems, wells, farm equipment and other property, livestock, and fences.

6. Sediment and scour damages to agricultural land were based on physical damage to the land and calculated in terms of dollars based upon reduced productivity. The value of recovery from this damage was discounted in accordance with the time required for and the extent of recovery.

7. The difference in damages expected under without project and with project conditions constitutes the benefits expected as the result of project installation.

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8. During periods of high flow, floodwaters originating in Cornudas, North and Culp Draws watershed also cause damage in Hitson, C&L and Washburn Draws watershed, and vice versa. Because of this interrelationship, floodwater damage reductions as the result of project installation were allocated to the various structures on the basis of the drainage area controlled.

9. The calculation of incidental ground water recharge benefits was based upon expected average annual recharge of the underground aquifer by recharge wells. The value of the recharge was based upon its effect in maintaining water quality with the resultant high level of management on irrigated cropland.

10. Indirect damages were estimated to approximate 10 percent of direct damages.

11. Secondary benefits stemming from the project were estimated to amount to 10 percent of direct damage reduction benefits.

12. The value of easements was determined by local appraisal, giving full consideration to current real estate market value. A comparison of the net value of agricultural production lost as the result of installation of structural measures to the amortized value of the easements showed the latter to be greater. The appraised value was, therefore, used in the economic evaluation.

Fish and Wildlife Resource Investigations

The Bureau of Sport Fisheries and Wildlife, in cooperation with the Texas Parks and Wildlife Department and the New Mexico Department of Game and Fish, has completed a reconnaissance study of the Cornudas, North and Culp Draws watershed. This report was invaluable in work plan development insofar as fish and wildlife resources are concerned. In addition to data presented under "Description of the Watershed" and "Effects of Works of Improvement," the following recommendations are reproduced from the report:

> The loss of brush resulting from the installation of project measures could be offset partly by planting vegetation of value to wildlife at appropriate locations such as idle lands, eroded areas, gullies, and around the floodwater retarding reservoirs. The wildlife plantings also would aid in erosion control.
>
> The small amount of surface water in the uplands of the watershed may limit the abundance of game animals. If interested, the landowners could consult with the Texas Parks and Wildlife Department or the New Mexico Department of Game and Fish regarding the feasibility of installing wildlife watering devices in the uplands. The administrators of public lands in the watershed might also consider installing these structures. Such water catchment devices can be built and installed for about $1,000 each. Possibly

some of the cost of the structures on private land could be shared under the Agricultural Stabilization and Conservation Service's G-4 program.

In view of the above, it is recommended that:

1. Losses of brush due to the building of project structural measures be offset partly by planting vegetation of value to wildlife at appropriate locations such as idle lands, eroded areas, gullies, and around reservoirs.

2. Landowners consult with the Texas Parks and Wildlife Department or the New Mexico Department of Game and Fish regarding the feasibility of installing wildlife watering devices on the uplands of the watershed.

The above recommendations are in conformance with the U.S.D.A. Soil Conservation Service Plant Sciences Memorandum-5, National Standards and Guides to Specifications for Conservation Practices in the Plant Sciences. If adopted as a part of the plan of development, losses of wildlife habitat would be mitigated and, additionally, fish and wildlife benefits would accrue to the project.

A detailed study of the watershed by the Bureau of Sport Fisheries and Wildlife is not considered necessary at this time. Should the sponsors desire, our Bureau, in cooperation with the Texas Parks and Wildlife Department and the New Mexico Department of Game and Fish, would be happy to be of further assistance.

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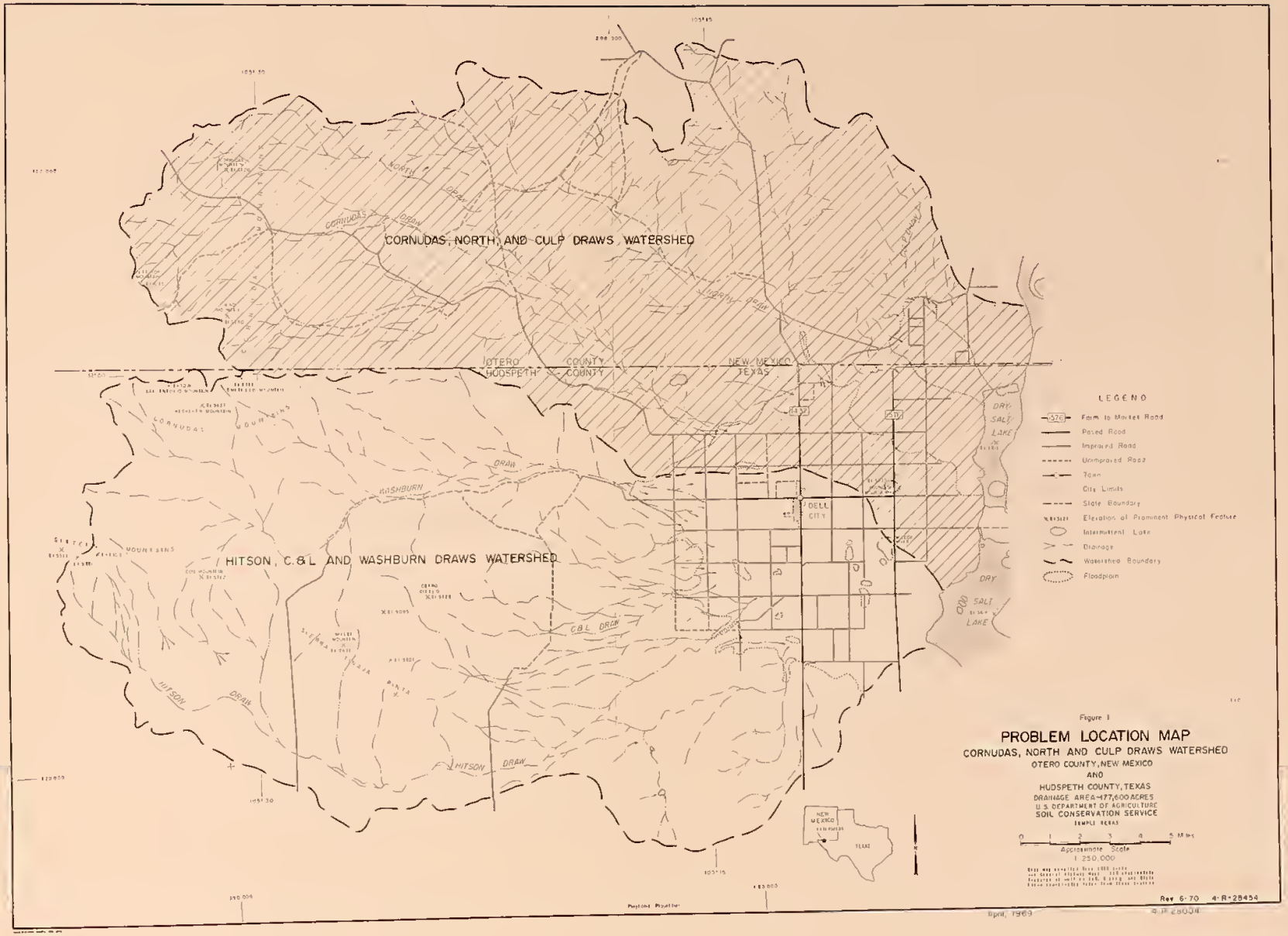


Figure 1

PROBLEM LOCATION MAP

CORNUDAS, NORTH AND CULP DRAWS WATERSHED
OTERO COUNTY, NEW MEXICO
AND
HUDSPETH COUNTY, TEXAS
DRAINAGE AREA-177,600 ACRES
U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
EMPIRE, TEXAS

Rev 6-70 4-R-28454

April, 1969

4-R-28004

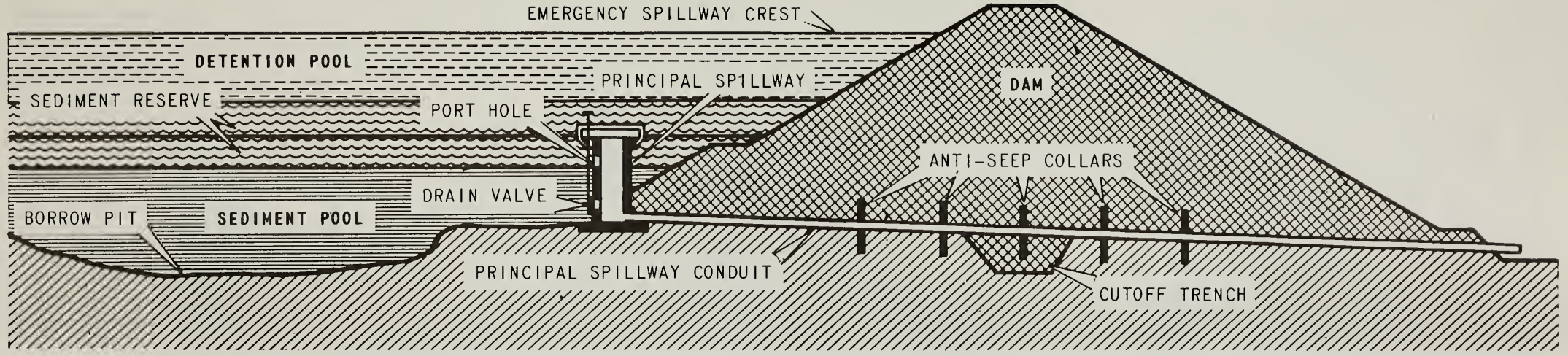
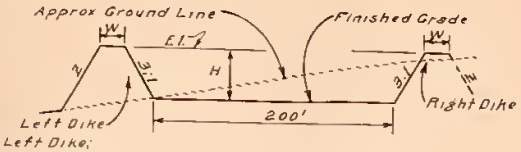


Figure 2

SECTION OF A TYPICAL FLOODWATER RETARDING STRUCTURE



Left Dike:
From Sta. 4+30 to Sta 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta 5+00 to Sta. 5+50 - a transition section
From Sta. 5+50 to approx. Sta. 6+30-W=10.0', Z=3:1, H=4.5'
Right Dike:
From Sta. 4+30 to Sta. 5+00-El.=1962.2, W=16.0', Z=2.5:1
From Sta. 5+00 to Sta. 5+50 - transition to W=10.0', Z=3:1, H=4.5'
Material forming dikes shall be placed and paid as "Earth Fill, Embankment".

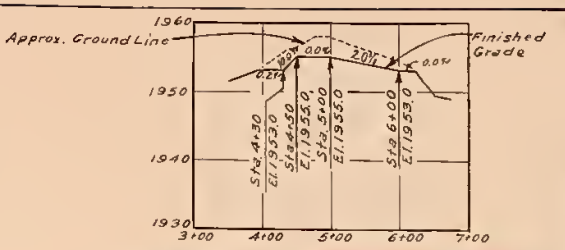
TYPICAL SECTION — EMERGENCY SPILLWAY

Emergency Spillway Diversions and Stub Diversions (S.D.): 18" effective height, 3:1 side slopes and 13 ft., minimum base, shall be constructed at the approximate locations shown on the plans. Final locations of the Stub Diversions shall be determined by the Engineer (See Construction Specification 5).

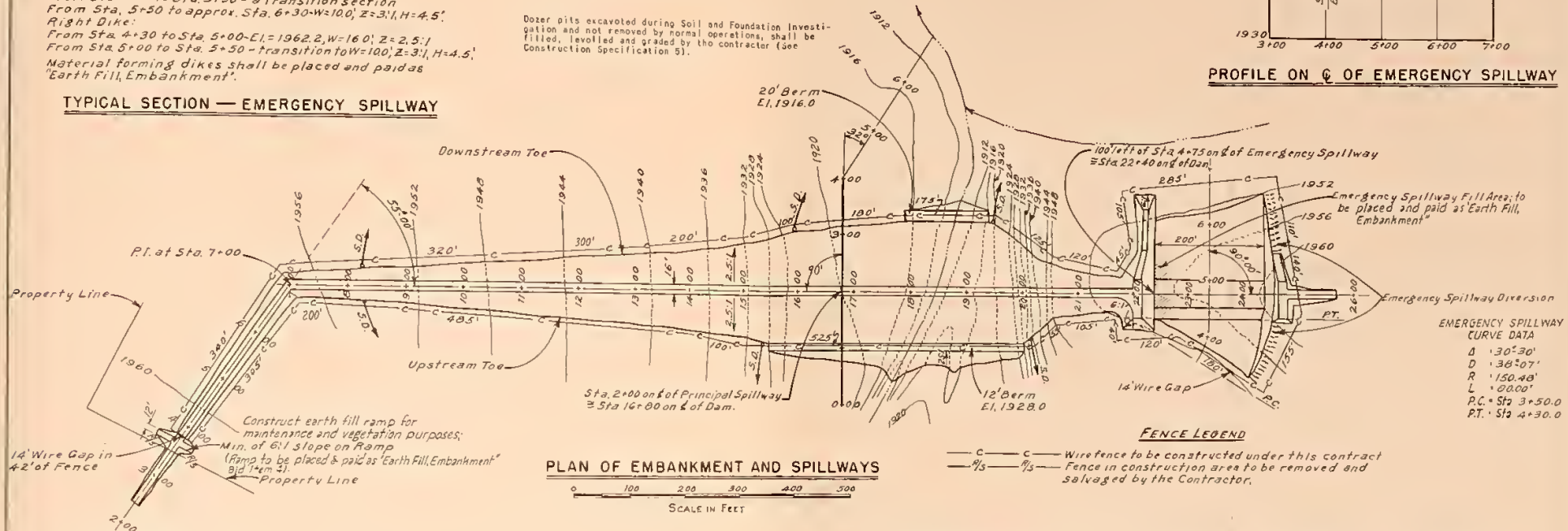
A minimum of 6" topsoil shall be placed in Emergency Spillway and on all Earth Fill Areas (See Construction Specification 20C).

Stream Channel within embankment area shall be shaped and cleared of objectionable material (See sheet 12 and Construction Specification 4).

Dozer pits excavated during Soil and Foundation Investigation and not removed by normal operations, shall be filled, levelled and graded by the contractor (See Construction Specification 5).



PROFILE ON ℄ OF EMERGENCY SPILLWAY

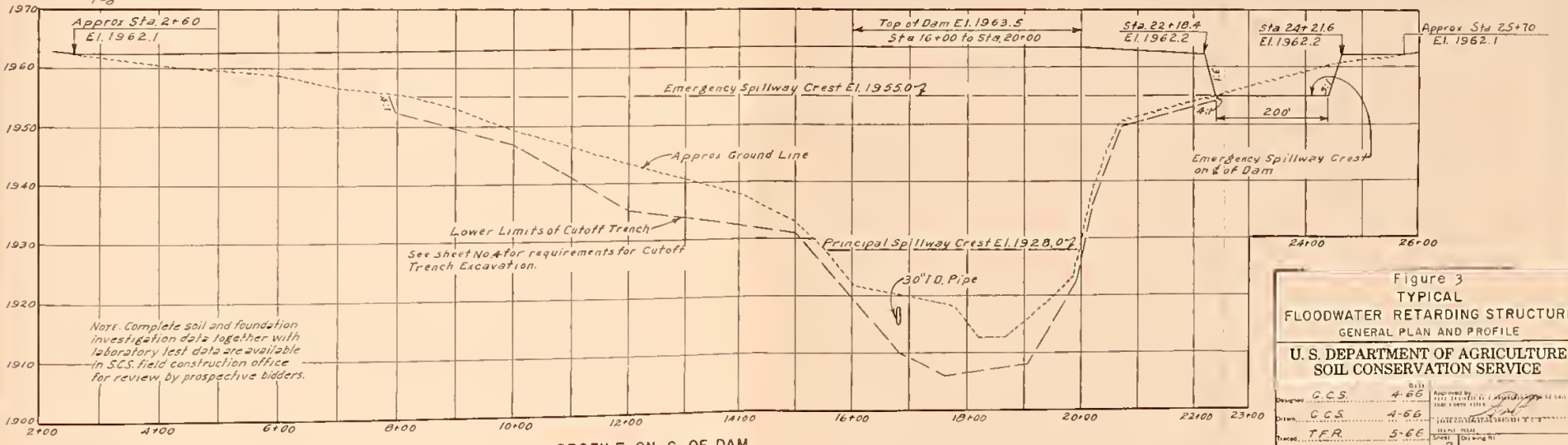


PLAN OF EMBANKMENT AND SPILLWAYS

0 100 200 300 400 500
SCALE IN FEET

FENCE LEGEND

—C—C— Wire fence to be constructed under this contract
—W/S—W/S— Fence in construction area to be removed and salvaged by the Contractor.



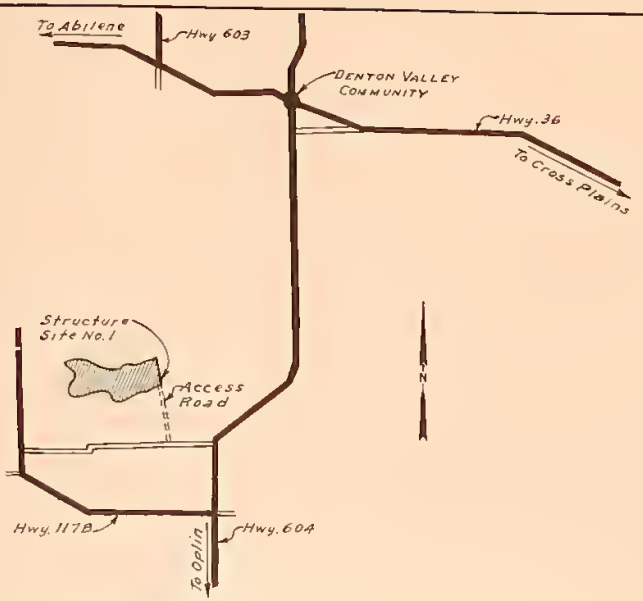
PROFILE ON ℄ OF DAM

Figure 3
TYPICAL
FLOODWATER RETARDING STRUCTURE
GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date
Designed	C.C.S.	4-66
Drawn	C.C.S.	4-66
Traced	T.F.R.	5-66
Checked	C.C.S.	5-66

Approved by [illegible]
State Texas
Sheet No. 2 of 13 Sheets
Drawing No. 4-E-21,594

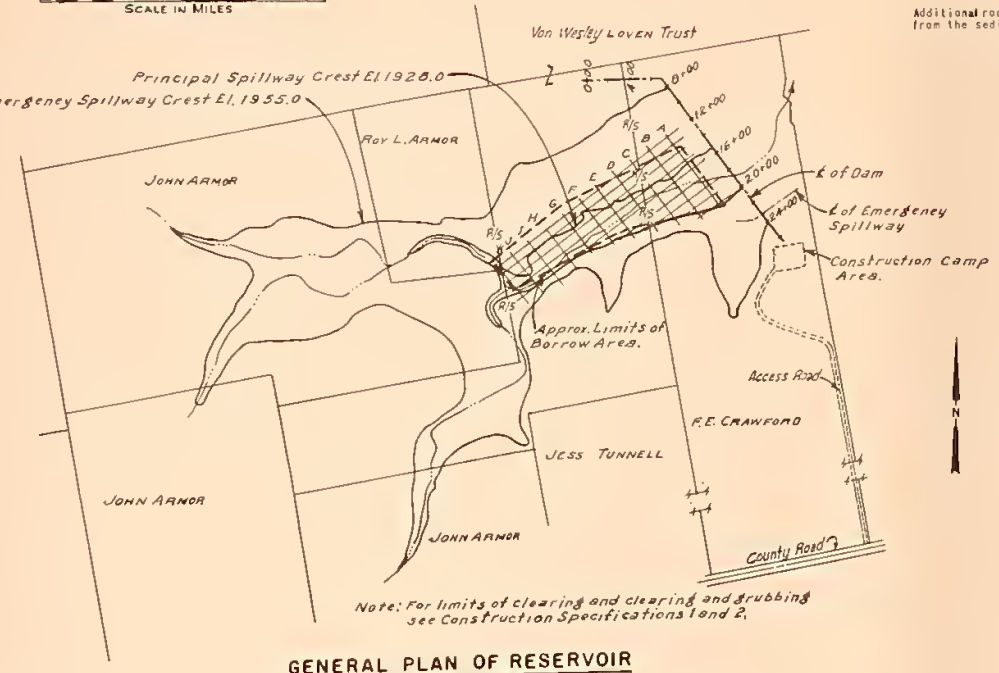


Structure site is located approx. 7 miles southwest of Denton Valley Community, Callahan County, Texas.

VICINITY MAP

0 1 2 3 4

SCALE IN MILES

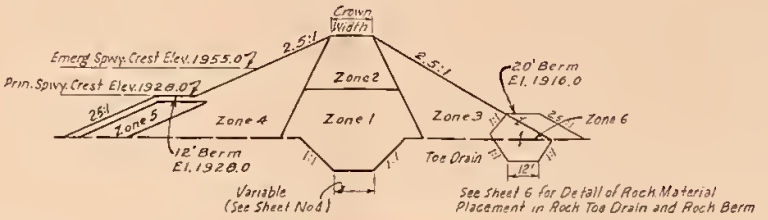


Note: For limits of clearing and clearing and grubbing see Construction Specifications 1 and 2.

GENERAL PLAN OF RESERVOIR

0 660 1320 1980 2640

SCALE IN FEET



See Sheet 6 for Detail of Rock Material Placement in Rock Toe Drain and Rock Berm

TYPICAL SECTION - ZONED EMBANKMENT

MATERIALS PLACEMENT DATA

Embankment Zone No. 1/	Source of Fill Materials: Material Location 2/	Average Depth, feet: From	To	Type or Unified Classification	Field Control Test: ASTM Test Number	Method	Placement and Compaction Requirements: Max. Allowable Particle Size	Max. Uncompacted Layer Thickness	Specified Compaction Class	Min. Dry Density, Percent of Field Test Max. Dry Density	Moisture Limits, Relative to Field Test Optimum: From	To	Laboratory Test Data: ASTM Test Number	Method	Curve No.	Max. Dry Density, p.c.f.	Optimum Moisture, %
1	Borrow	0	3	CL	D698	A or B	6"	9"	A	95	-2	+4	D698	A	5	101.5	20.5
	Borrow	0	6	CL	D698	A or B	6"	9"	A	95	-2	+3	D698	A	6	113.0	14.0
	Borrow	0	4	SC	D698	A or B	6"	9"	A	95	-1	+3	D698	A	3	116.5	13.0
2 & 3	Borrow	4	12	GC	D698	D	6"	9"	A	95	Opt.	+4	D698	C	2	130.0	7.0
4	Borrow	0	7	SM	D698	A or B	6"	9"	A	95	-1	+4	D698	A	4	121.5	11.0
5	Borrow	0	4	SM	D698	A or B	6"	9"	A	95	Opt.	+4	D698	A	1	116.0	11.5
2 & 3	Emerg. Spwy	0	Grade	GC	D698	D	6"	9"	A	95	Opt	4	Not Tested				
6	3/	Durable Rock					24"	36"									

1/ The zone boundaries shown in the typical section are approximate. Adjustments will be made by the Engineer to permit the use, within the neat lines of the embankment, of all suitable materials from the required excavations.

2/ Materials from the required excavations that are not tabulated in the table above and that are suitable and acceptable for earth fill shall have the same placement and control requirements as that specified for like materials under Materials Placement Data.

3/ Rock Material to be used for the Rock Toe Drain, Berm, and Channel liner shall be precured from required excavations.

Additional rock materials required in excess of that obtained from specified excavations shall be combed, raked or otherwise harvested from the sediment pool, detention pool, or surrounding areas. (See Construction Specification 5).

ZONED EMBANKMENT DATA

All usable material from within the sediment pool shall be used prior to enlarging borrow area outside these limits. Borrow from outside the sediment pool shall be obtained only as directed by the Engineer.

Elevation	Surface Acres	Storage: Acre Feet	Inches
1910	1	3	.0
1920	3	11	.02
1924	9	35	.05
1928	13	79	.12
1932	22	149	.23
1934.1	27	207	.32
1936	32	257	.40
1940	47	415	.65
1944	71	651	1.01
1948	96	985	1.53
1952	130	1437	2.24
1955	155	1864	2.90
1956	163	2023	3.15
1960	197	2743	4.27
1962.1	221	3182	4.95
1964	243	3623	5.64

Top of Dam (Effective) Elev.	1962.1
Emergency Spillway Crest Elev.	1955.0
Principal Spillway Crest Elev.	1928.0
Sediment Pool Elev.	1928.0
Drainage Area, Acres	7706.
Sediment Storage, Acre Feet	207.
Floodwater Storage, Acre Feet	1657.
Max. Emergency Spillway Cap., cfs	14020.

Figure 3

TYPICAL

FLOODWATER RETARDING STRUCTURE

GENERAL PLAN AND PROFILE

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

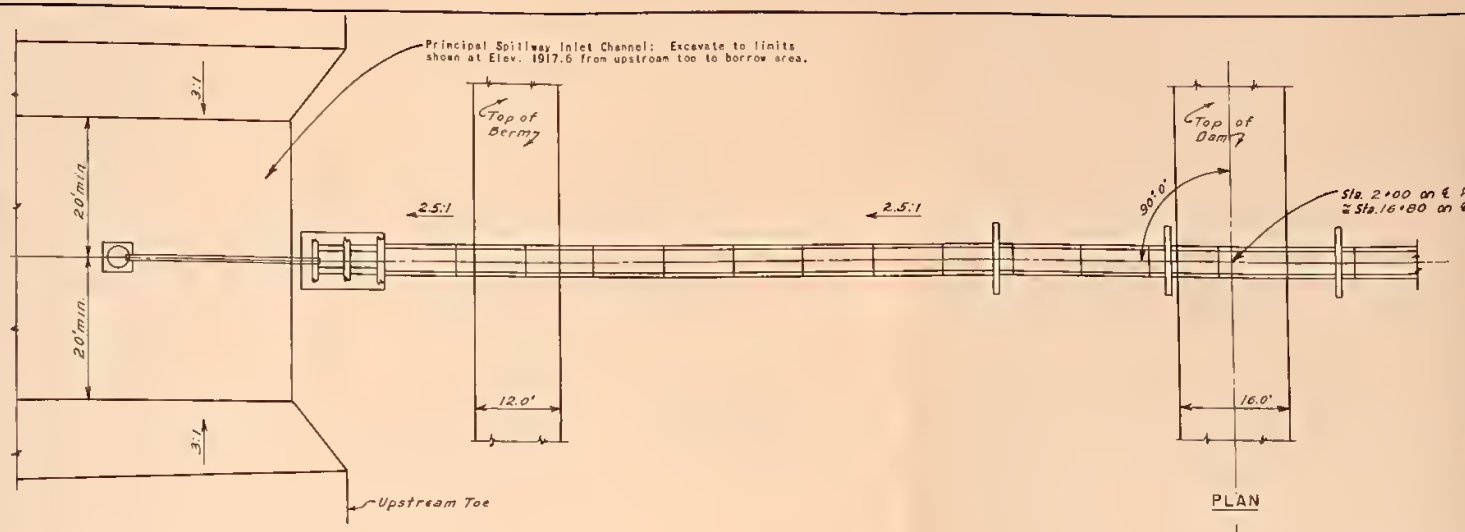
		Date
Designed	G.C.S.	4-66
Drawn	G.C.S.	4-66
Traced	T.F.R.	5-66
Checked	G.C.S.	5-66

Approved by [illegible] DIRECTOR

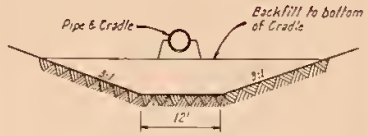
DATE [illegible]

Sheet No. 3 of 13 Sheets

Drawing No. 4-E-21,594



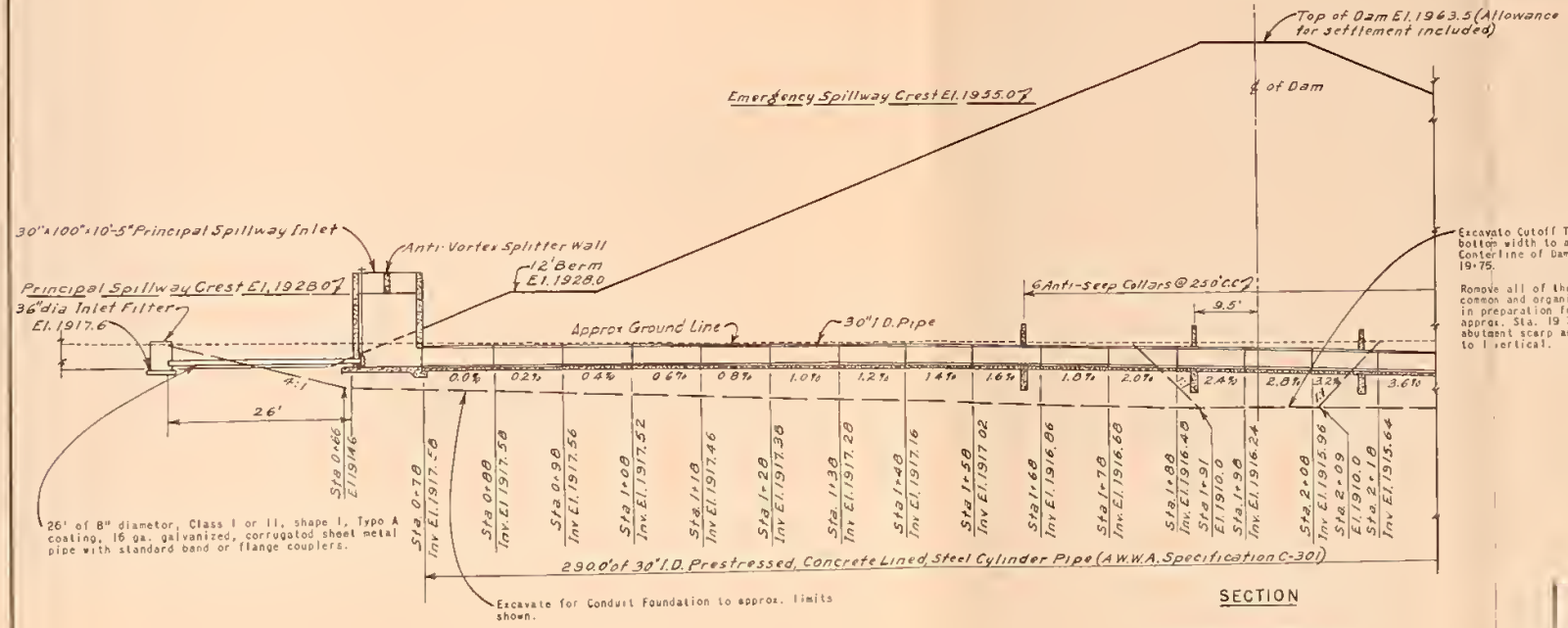
PLAN



Excavation to be paid as "Excavation, Unclassified".

Prior to placing backfill around the structure, the surface layer of the in-place fill material shall be reworked as necessary, and to the depth necessary, to restore and satisfy the density and moisture requirements specified for that fill material.

TYPICAL CONDUIT FOUNDATION EXCAVATION



SECTION

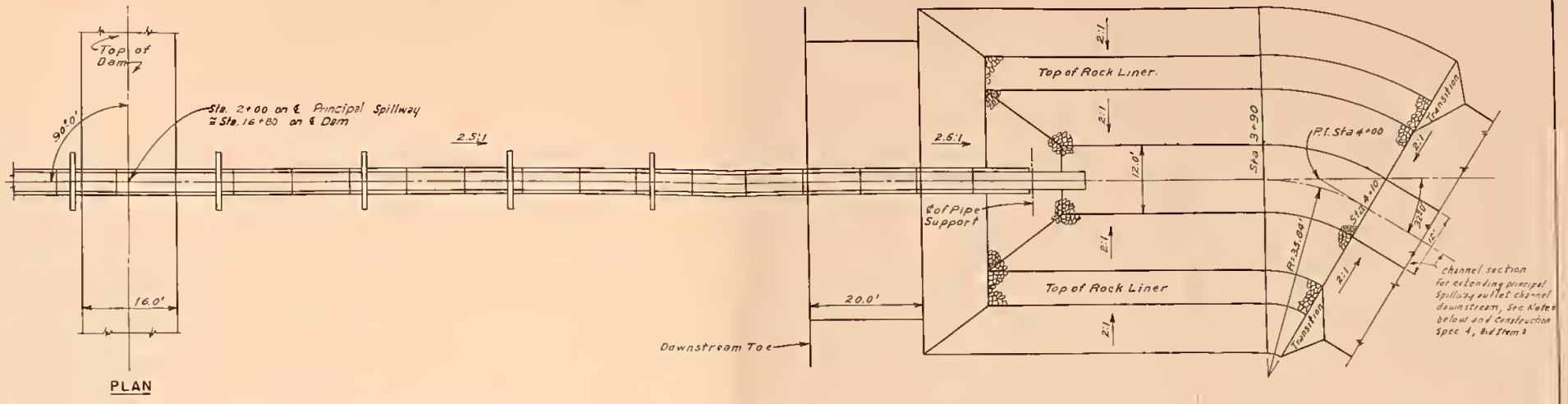
PRINCIPAL SPILLWAY

Figure 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

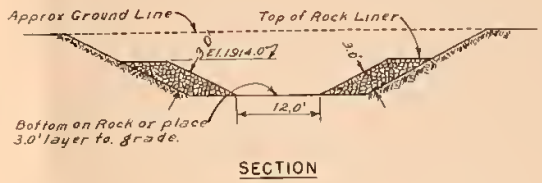
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	
Designed	G.C.S.	4-66	Approved by
Drawn	G.C.S.	4-66	
Traced	T.F.R.	5-66	
Checked	G.C.S.	5-66	Sheet No. 4 of 13

Drawing No. 4-E-21,594



PLAN



SECTION

NOTE: Excavation for the Rock lined Channel shall be paid as "Excavation, Unclassified". Place a 3.0 ft. thickness of dumped rock to dimensions shown in the drawings with rock size grading from small at subgrade to large at finished grade. Placement of spalls and cobbles shall precede dumping of boulders. Rock material shall be placed to reasonably neat lines of the finished grade. Payment for placing rock fill in channel is not a separate item; such cost shall be considered "Earth Fill, Embankment" and paid for as such. Rock against Principal Spillway shall be placed so as to avoid damage to pipe and other structural works. See sheet 3 for sources of Rock Material.

SECTION

PRINCIPAL SPILLWAY

Figure 3A
TYPICAL
FLOODWATER RETARDING STRUCTURE
STRUCTURE PLAN AND SECTION

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

		Date	Approved by
Designed	G.C.S.	4-66	
Drawn	G.C.S.	4-66	
Traced	T.F.R.	5-66	
Checked	G.C.S.	5-66	Sheet No. 5 of 13

Drawing No. 4-E-21,594

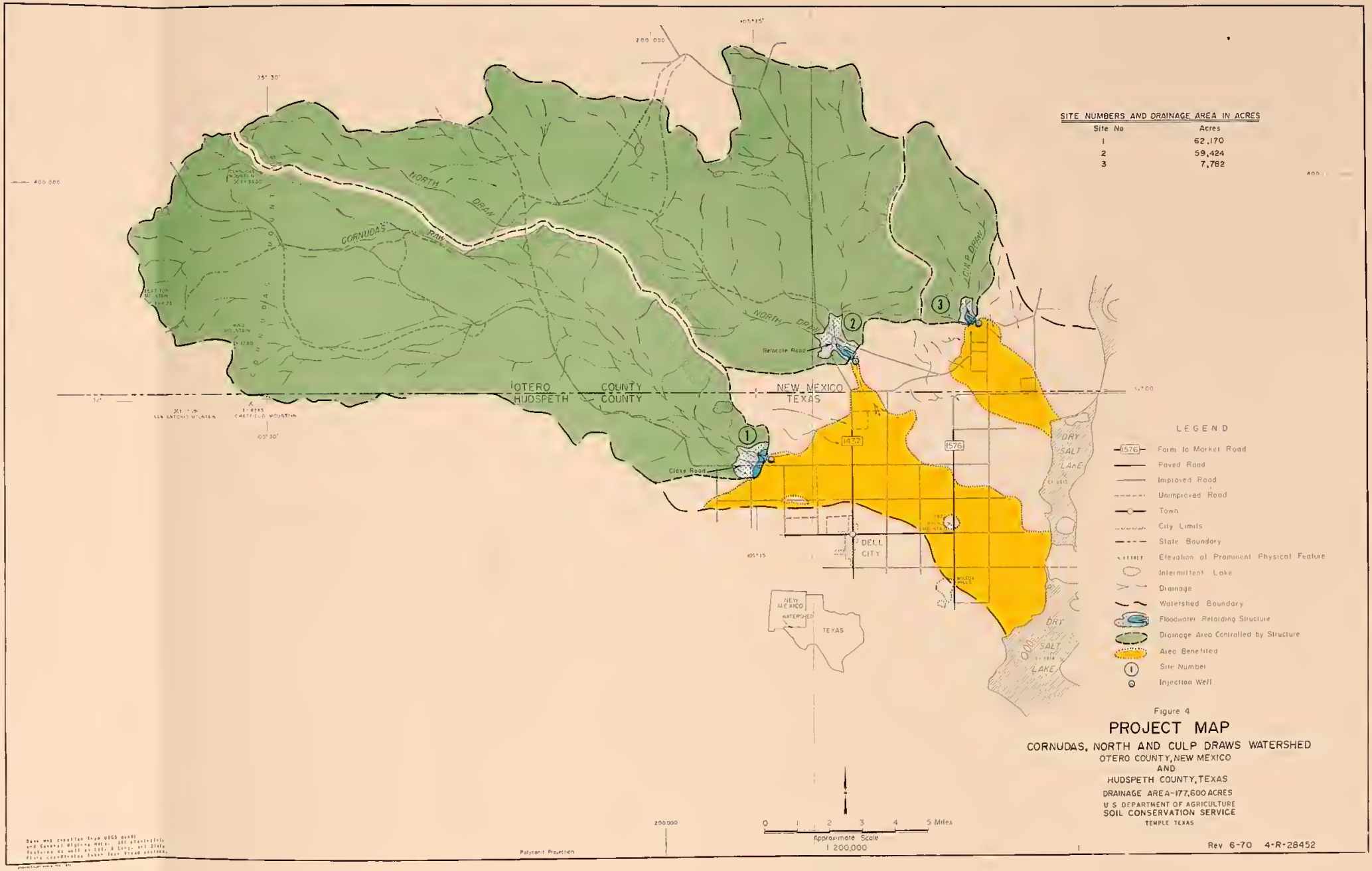


Figure 4

PROJECT MAP

CORNUDAS, NORTH AND CULP DRAWS WATERSHED
OTERO COUNTY, NEW MEXICO
AND
HUDSPETH COUNTY, TEXAS
DRAINAGE AREA-177,600 ACRES
U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEMPLE TEXAS

Rev 6-70 4-R-28452